# The Canadian Entomologist

Vol. LXXXV Ottawa, Canada, November 1953 No. 11

## The Tachinid Parasites of *Archips cerasivorana* Fitch. (2) *Eusisyropa blanda* O. S. (Diptera)

*By* W. R. Thompson

Commonwealth Institute of Biological Control

This is the species referred to in the first paper on the parasites of *Archips cerasivorana* (Can. Ent., Vol. LXXXV, No. 1, pp. 19-30) under the name *Zenillia blanda*. The genus Eusisyropa was created by Townsend (Smiths. Misc. Colls., Vol. 51, p. 97, 1908) with *blanda* O.S. as type. In it he also included *boarmiae* Coq.. Aldrich and Webber (Proc. U.S. Nat. Mus., Vol. 63, Art. 7, 1924) placed these in Zenillia R.-D. but most workers agree that they collected a very heterogeneous assemblage of species under this name. As will be explained later, the efforts to subdivide the group on adult characters have not been entirely satisfactory. It seems best to use the restricted genera available until the matter has been studied in detail.

### Egg and Larval Stages

Egg

The egg is oval, (l, 0.11 mm., w., 0.1 mm.) rather acute at the anterior or micropylar end, broadly rounded at the posterior end; the ventral surface is thin and transparent, the dorsal surface thickened and divided into narrow, elongate polygonal areas, the surface of which is rather coarsely punctate[1]; in a dissected female (det. A. R. Brooks) from the Canadian National Collection, the egg shell was transparent and colourless, although the larva was well developed. Hatched eggs found in the mid-intestine of *cerasivorana* caterpillars were pigmented, pale grey in colour, but the pigmentation appears to be in the vitelline membrane, not in the chorion. The condition observed is rather unusual and contrasts strongly with that found in the allied *Euexorista futilis* O.S. where the chorion becomes heavily pigmented long before the larva is fully developed.[2]

Stage I. (length 0.36 mm.; width 0.14 mm.).

The larva has the usual characters of those developing in microtype eggs. The skin is thin, transparent and colourless; the sensorial organs are generally reduced; however, the antennae, though small, are distinct, hemispherical in form; on the first three segments, Keilin's organ, which marks the insertion of the histoblasts of the imaginal legs, is unusually distinct, composed of two pale setae, inserted one in front of the other; a short distance cephalad is a similar isolated seta; a short rod-shaped sensorium lies near the dorsal edge of the ventral region, near the anterior spine-band, on segments IV to VII; a number of similar sensoria exist on the last abdominal segment; the first three segments bear complete bands of strong black, curved, backwardly directed spines on the anterior border; these bands are thickest dorsally and ventrally, where they consist of

[1]Townsend erroneously described the egg of this species (Manual of Myiology, pt. IV, p. 241) as having the chlorion absolutely plain. It is true that the sculpture is rather inconspicuous.

[2]An interesting problem in connection with ovoviviparous Tachinids is the internal determinism of oviposition, stimulated externally by the perception of the host, at least in most cases. Generally speaking the eggs should contain larvae ready to emerge at the time they are deposited, otherwise the eggs of forms such as *blanda* would be eaten and excreted while still undeveloped. In experiments on *Blepharipoda scutellata* R.-D. the writer found that unfertilized females having the uterus full of sterile unpigmented eggs will deposit them on leaves. This suggests that the stimulus may be mechanical and depends on uterine distension. But in that case the rate of devlopment must be such that when the last eggs necessary to distend the uterus are descending from the ovarioles, the first eggs must normally contain fully formed larvae, ready to emerge. In fact however, as stated above, some species such as *Euexorista futilis* O.S. may have the uterus distended with pigmented eggs which are still undeveloped, even at the lower end. The mechanism involved is not easy to conceive.

three or four rows; they thin out in the pleural regions; the anterior spines are the most elongate, the posterior spines the shortest; on the 2nd and 3rd segments the bands become progressively narrower and the spines sparser, particularly in the pleural area; on segment IV there is a single anterior row, interrupted by a bare pleural area, in the middle of which is a pair of spines; on segment V the dorsal band is represented only by 3 small spines on each side, in the dorso-pleural area; the pleural pair does not exist; but the dorsal end of the ventral band is interrupted, isolating the two dorsal spines of the band; the ventral band comprises a single row of spines, except in the mid-ventral region where they are doubled; on segments VI, to X, there are rather short ventral rows, separated on each segment from a ventro-pleural group of 3 or 4 spines; on the posterior border of segment X is a small group of anteriorly directed spines; no dorsal spines are present on segments VI to XI; the spines of the anterior segments are deeply pigmented, but become paler posteriorly. The respiratory system is metapneustic; the felt-chambers short (l. 0.0075 mm., w. 0.005 mm.) each terminating in 2 small spiracular slits. The buccopharyngeal armature (Fig. 3) is of the form usual in microtype larvae and closely resembles that of the larva described by the writer (Ann. Paras. Hum. et Comp., T. IV, No. 3, 1926) under the name of *Exorista fimbriata* Meig., (Fig. 14) (now referred by Mesnil to the genus *Platymyia*) from a specimen in the Cambridge University collection. However, the anterior region in *blanda* makes a more acute angle with the intermediate region than in *fimbriata* and it is slightly longer (length, *E. blanda*, 0.0125 mm. *P. fimbriata* 0.0075 mm.) and more heavily pigmented.[3] Anterior tooth slender, acute, directed downward and slightly forward, with a distinct short sharp dorsal tooth at the base; length about ½ the basal portion, whose ventral side runs into the ventral border of the tooth in a gentle continuous curve; height of basal portion of anterior region at junction with tooth about twice that at the junction with the intermediate region, which is about the same length as the anterior region, including the tooth; posterior region, from the anterior edge of the ventral wing to the tip of the dorsal wing, slightly longer than the anterior and intermediate regions together; dorsal wing elongate, very slightly curved, the interalar space sub-acute in front, about twice as wide as the dorsal wing; ventral wing about half the length of the dorsal wing, rounded posteriorly, pigmentation pale except for a narrow dorsal band; lateral anterior sclerites distinct, rather broad, with a circular sensorium at the tip; sclerite of the salivary gland not distinctly separated from the intermediate region.

At the end of the first stage the posterior wings have extended in area by a diffusion of chitinization so that they are now indistinctly defined.

Stage II.

No complete larvae in this stage were found during the dissections. The only anatomical data concern the buccopharyngeal armature, (Fig. 4) which is, however, of rather distinctive form and will probably suffice to separate *E. blanda* from the other parasites of *A. cerasivorana*. The parts of the armature are solidly fused, without any distinct articulation (l 0.2145 mm.), though some specimens show a short indistinct incision on the dorsal side, between the intermediate region and the base of the dorsal wing of the posterior region. Anterior region (l. 0.057 mm.) of each side in the form of a slender, elongate, strongly curved hook, acute at the tip, broadening rather abruptly at the base; intermediate region not distinctly differentiated from basal part of anterior region, the two regions together only slightly shorter than the dorsal wing of the posterior region; dorsal wing roughly semi-oval in outline; interalar space broadly rounded

[3]The egg of *fimbriata* in my material, is thin and only faintly pigmented, though it contains a fully developed larvae; in this respect also, it resembles *E. blanda*.

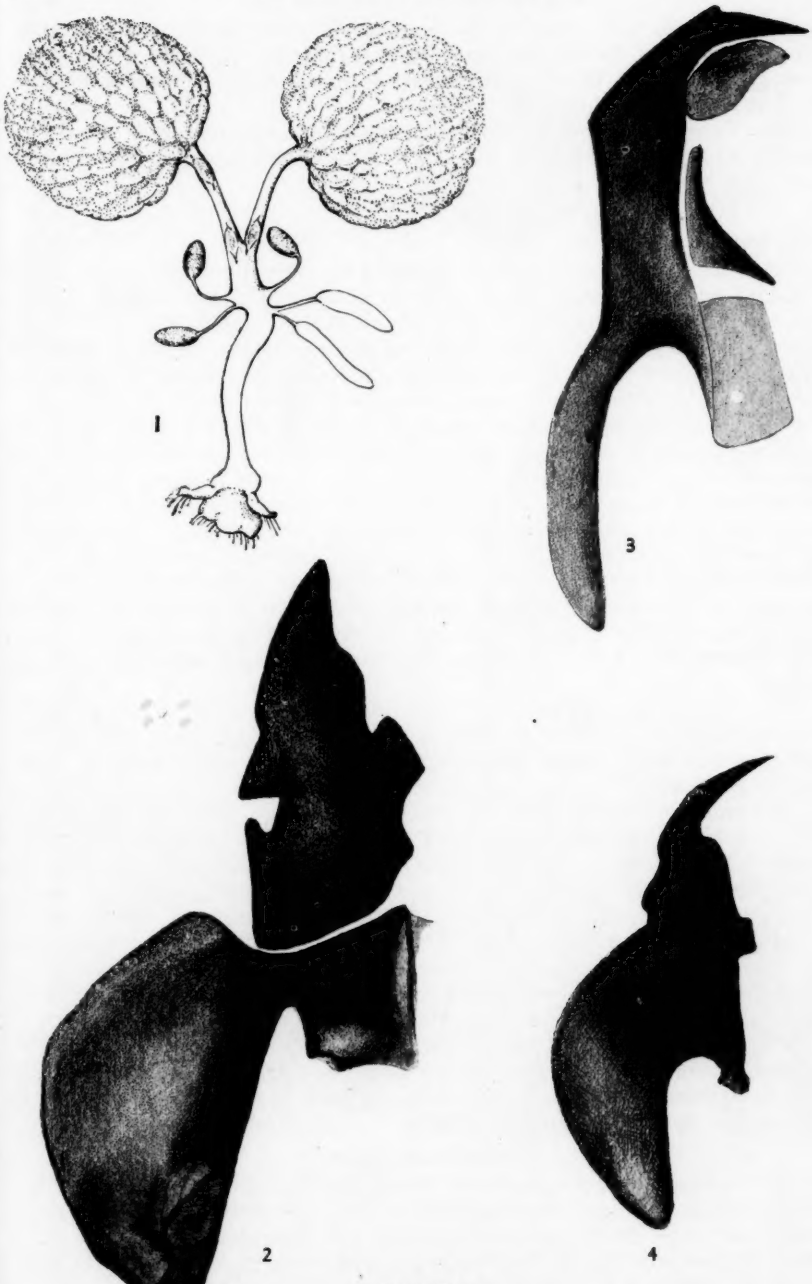



PLATE 1

*Eusisyropa blanda* O.S.: Fig. 1, female reproductive system, showing ovaries, oviducts, spermathecae, accessory glands and uterus; 2, buccopharyngeal armature, stage III; 3, buccopharyngeal armature, stage I; 4, buccopharyngeal armature, stage II.

in front, ventral wing short, truncate posteriorly; the dorsal wing, measured from the bottom of the interalar space, about 6 times as long as the ventral wing. In moulted armatures, the two mandibular sclerites diverge widely laterally from the junction with the intermediate region.

The form of the stage II armature resembles, in minature, that of the corresponding stage of *Blepharipoda scutellata* R.-D. It differs greatly from that of *Zenillia libatrix*.

The posterior spiracles were not found.

Stage III.

The characters of this stage are described from the puparium. The cuticle is studded with short broad spines, (Fig. 7) much longer than those of *D. leucoptera*. The buccopharyngeal armature (l. 0.5148 mm.) (Fig. 2) has the anterior and intermediate regions fused; but the intermediate region is separated from the posterior region by an articulation; the anterior region terminates on each side in a stout moderately acute, forwardly directed tooth; between the base of the tooth and the intermediate region, on the dorsal side, is a deep trapezoidal notch; the sclerite of the salivary gland is distinct but fused at the sides with the intermediate region; the anterior and intermediate regions together, are slightly shorter than the dorsal wing of the posterior region; the dorsal wing is straight on the ventral side which is oblique in relation to the long axis of the armature; the dorsal side is roughly semi-circular in outline, slightly produced in front, above the intermediate region; some rounded pale areas appear near the posterior extremity of the wing; the interalar space is subacute at the bottom; the ventral wing is short and broad, truncate behind, less than half the length of the dorsal wing, measured along the ventral line from the bottom of the interalar space to the end.

The anterior spiracles (Fig. 6, 9) are inconspicuous, only slightly elevated; each terminates in a pair of respiratory papillae, the line joining the papillae parallel to the dorso-ventral plane of the puparium; in some spiracles, three papillae are present.

The posterior spiracles (Fig. 10) are practically apical, the basal area shining black in contrast with the bright red of the puparial wall, approximately semi-circular in outline, (diameter 0.215 mm.) the distance separating the spiracles usually less than half the transverse diameter of one of them; each usually bears four undulating slits; the line joining the moulting scars (or 'spiracular buttons"), separates the dorsal and ventral slits; in some specimens, only three slits on one side. The exact form of the puparial slits varies a good deal in different specimens; none of those examined, however, closely resemble those of the allied *E. virilis* as figured by Sellers (Ann. Ent. Soc. Amer., Vol. 23, pp. 569-576, 1930).

The prothoracic respiratory system (Fig. 11) differs markedly from that of D. *leucoptera* in the presence of the spiracular cornicle and the trachea leading to it; the spiracular plate bears from 60 to 70 papillae, while there are about a dozen on the tip of the spiracular cornicle.

**Reproductive System**

As is normal in species producing microtype eggs, the ovaries (Figs. 1, 5) are voluminous, with many ovarioles, each comprising a distinct elongate terminal chamber and some 10-12 eggs, each enclosed with its groups of nutritive cells, which diminish in size as the egg enlarges (polytrophic type). When the egg-shell forms, which is usually in the 8th or 9th chamber from the tip of the ovariole, the egg suddenly becomes detached from the wall of the egg-chamber. The spermathecae are oblong-oval in form with a rather darkly pigmented capsule; the accessory glands are moderately well developed.

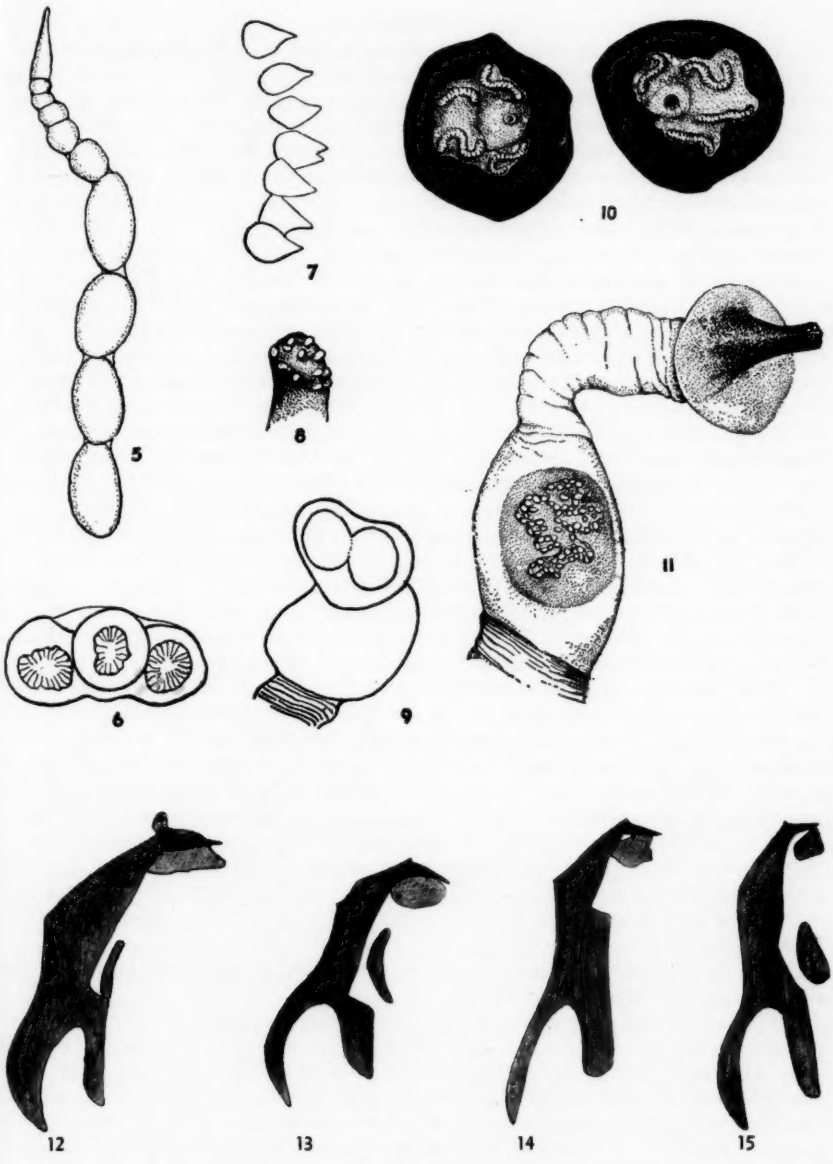



PLATE 2

*Eusisyropa blanda* O.S., Fig. 5, ovariole; 6, anterior spiracle (with 3 papillae), surface view, stage III; 7, cuticular scales, stage III; 8, tip of pupal respiratory cornicle; 9, anterior spiracle (with 2 papillae) and "felt-chamber", stage III; 10, posterior spiracles, from puparium (stage III); 11, pupal respiratory cornicle and internal spiracle; 12, buccopharyngeal armature, *Chaetogaedia ochriceps* v.d.W., stage I; 13, same, *Patelloa pachypyga* A. & W.; 14, same, *Platymyia fimbriata* Meig.; 15, same, *Sturmia bella* Meig.

**Biology**

*Eusisyropa blanda* O.S. has a microtype egg which contains, when it is deposited, a larva ready to hatch. Such species are generally believed to oviposit on the food of the host—in this case the leaves of the cherry on which *cerasivorana* feeds. The eggs are ingested with the food and hatch in the alimentary canal. The larvae then traverse the intestinal wall and install themselves in some organ of the host. However, not many species with microtype eggs have been thoroughly studied, so some departures from the habits described may occur. The writer (Ann. Paras. Hum. et Comp., T. II, No. 3, 1924) found that in some species, eggs with the chorion heavily pigmented, suggesting maturity, still contained undeveloped larvae. Townsend (l.c., Pt. IV, p. 167) observed this in other forms. From this Townsend concluded that the eggs are deposited "where the host will not immediately swallow them but also where they will stand a fair chance of being swallowed by the latter at any time after a lapse of some 24 to 48 hours". If the eggs are still undeveloped when ingested, it seems, as Townsend pointed out, that they would be evacuated and lost before hatching. A more simple explanation would be that embryological development and the pigmentation of the chorion are not synchronous and that only immature specimens of the flies had been dissected. In *Eusisyropa blanda* eggs containing well-developed larvae may have a practically unpigmented chorion. Some specimens of *Euexorista futilis*, as already noted, show undeveloped larvae in eggs with a heavily pigmented chorion; but in others the larvae are quite well developed. Material of Phosococephalops sp., collected in Trinidad, included some females with strongly pigmented eggs containing undeveloped larvae; but in others the larvae were well formed. In these forms, at least, it is therefore not necessary to assure any deviation from the normal habit.

However this may be, it is certain that the eggs of *blanda* are laid on the food of the host and ingested by it. A caterpillar collected at Malwood, Ontario, on June 22 and preserved on the same date, contained in the mid-intestine, 4 hatched eggs and 4 very small and evidently newly hatched larvae, still in the food mass enclosed by the peritrophic membrane. The eggs were then not colorless but pale grey. A rather faint pigmentation had therefore developed after the cuticular larval characters had become apparent. It should be noted that one larva was found (in another specimen) in the anterior part of the hind intestine which indicates that hatching does not always occur at the same time or else the larva is unable to issue from the food mass before it passes out of the ventriculus.

The fact that several eggs and larvae were found in individual hosts suggests that the eggs are deposited in batches.

Owing to the fact that all the *cerasivorana* caterpillars available were preserved rather too early, the larval biology has not been completely worked out. However, one interesting point has been established: that the first stage larva, instead of passing directly through the peritrophic membrane and the intestinal wall, remains attached to it for a considerable time, with the head buried in the epithelium. In fact, of the 15 larvae found in dissections, all were attached to the intestinal wall. The period covered was short, since the caterpillars of *cerasivorana* were collected (at various points in the Ottawa area) between June 12 and June 22. However, the fact that in all but one specimen, the egg shells had disappeared from the intestine, suggests that the primary larva does settle there for a time.

The existence of this rather peculiar habit, not hitherto described, so far as the writer is aware, is confirmed by some observations made in 1911 by the writer at Ithaca, N.Y. During the course of a study of the biology of *Pelatachina pellucida*

Coq. a number of Tachinids were collected in a colony of *Nymphalis antiopa* L. on elm. Among these was a female identified at the time as *Phorocera doryphorae* Riley, in the tables of Coquillett's "Revision of the Tachinidae of America North of Mexico" (1897). This fly was dissected and found to contain microtype eggs and larvae. It cannot therefore have been *Phorocera doryphorae* (now placed in the genus Doryphorophaga) since this species, which is a parasite of the larvae of the Potato Beetle, has a piercing ovipositor and deposits larvae in elongate thin-shelled cylindrical eggs. The fly has since been lost, but the reproductive system with eggs and larvae was preserved. The eggs are of the distinctive type called by Townsend, "patelliform" because of their resemblance to the Molluscs of the genus Patella, commonly known as limpets. They are obconical with a rounded punctuate central area around which are concentric folds. Townsend first observed this type in "*Phorocera*" *leucaniae* Coq. and this apparently explains the name of the genus Patelloa which he erected for this species (1916, Proc. U.S. Nat. Mus., Vol. 49, p. 619). In their 1924 paper on Phorocera (Proc. U.S. Nat. Mus., Vol. 63, Art. 17), Aldrich and Webber sunk Patelloa as a genus but conserved it as a subgenus, including 11 species, of which 7 were new. Of these, all but 3 are western or southern and only two–*leucaniae* Coq. and *pachypyga* A. & W. are known to exist in North-eastern North America. A very common species–*pachypyga* A. & W.– was not described until 1924. It is therefore not included in Coquillett's "Revision". This species resembles *doryphorae* in the short third antennal joint and the broad front. If therefore the fly was correctly placed as close to *leucaniae*, it was probably *pachypyga*. A study of the primary larva shows that it was not *leucaniae*, which has much longer ventral abdominal spines and is moreover much larger. The egg is of the Patelloa type and closely resembles that of *pachypyga* as does the larva. I therefore refer it with some doubt to this species, though there may be patelliform eggs in other genera not yet investigated.

Since the "Phorocera" was collected in a colony of *Nymphalis antiopa* it might have been one of the parasites of this host. However, all the known Tachinids attacking *antiopa*–*Achaetoneura* spp., *Pelatachina tibialis* Coq. and *Madremyia saundersi* Will.,–deposit elongate thin-shelled eggs containing larvae of types quite different from Patelloa.

At any rate, when the microtype eggs were found, a number of them were spread on elm leaves and fed on June 1, 1911 to large caterpillars of *Nymphalis antiopa*. Later on the same day a caterpillar was opened. Two unhatched eggs were found in the food mass in the ventriculus and also two newly hatched larvae between the peritrophic membrane and the intestinal epithelium. A few hours afterwards larvae were found with their heads buried in the epithelium and it was assumed that they were caught in the act of transversing it. However, on June 5 the mid-gut of a caterpillar of *antiopa* was found to bear small white swellings each containing a living larva of the Tachinid. On June 12 dissection showed that they were still in the same position. Excessive heat in the greenhouse where the caterpillars were being reared killed them about this time so their subsequent behaviour was not determined. Nevertheless it does seem from the facts now known, that life with a cephalic attachment to the inner side of the mid-intestinal wall is normal in some Tachinids.

Little is known about the behaviour of *blanda* in later stages. When Tachinid larvae make a secondary respiratory opening, either in the trachea of the host or in its skin, the remains of the respiratory funnels can usually be discovered after the parasite larva has finished feeding. No such remains have been found in pupae from which *blanda* has issued. On the other hand,

the first and second stage mouth-hooks have been found. This suggests that the first stage larva may eventually pass through the intestine into the body cavity and live there without a respiratory attachment, since the moult skins, if shed into the intestine, would probably become attached to the peritrophic membrane and be carried out by the food mass. It is hoped that this matter can be cleared up.

Unlike *Dichaetoneura leucoptera* which pupates within the emptied pupal case of the host, *E. blanda* after devouring completely the contents of the host pupa and casting its meconium, issues from the pupa and pupates beside it in the cocoon, with its anterior end toward the opening of the cocoon.

Sellers, in his monograph of Zenillia (Proc. U.S.N. Mus., Vol. 93, pp. 1-108, 1943) where an extensive host list is given, notes that *blanda*, like *virilis*, if parasitic on hosts producing adults the same season, completes its development that season, but if parasitic on hosts that pass the winter in the pupal stage and emerge the following spring or summer, does not emerge until the following spring. Hibernation occurs in this case as a larva within the host pupa.

**Systematic Relationships**

The taxonomic history of *Eusisyropa blanda* O.S. and its synonymy, is given by Sellers in his monograph of the nearctic species of Zenillia and allied genera (l.c. 1943). The species was originally described in the genus Exorista by Osten Sacken but placed, with *boarmiae* Coq., by Townsend in a new genus, Eusisyropa, in 1908. Aldrich and Webber, in 1924, made *boarmiae* a synonym of *blanda* and divided this into two subspecies: *blanda blanda* and *blanda virilis*, placing them, together with *blandita*, *ceratomiae* and *futilis* in Eusisyropa to which they gave the status of a subgenus, in the genus Zenillia R.-D. Sellers referred *blanda* and *boarmiae*, with the new species *tucumanensis* and *autographae*, to Eusisyropa, excluding *blandita*, *futilis* and *ceratomiae* which he showed to be a synonym of *hyphantriae* Towns.; but as he could see no object in attempting to use the restricted generic concepts with the information available, he placed all the species mentioned, together with the type-species, *libatrix* Panz., in the genus Zenillia.

In the latest section of his monograph of the Palaearctic Tachinids (Lindner, Fasc. 172, pp. 257-304, 1953) Mesnil puts Zenillia (type *libatrix* Panz.) in the tribe Salmaciini (or Goniini), sub-tribe Masicerina. One of the characters used in defining the sections of the Masicerina is the humeral chaetotaxy. In the section containing the true Zenillias, (Masicerariae) the three basal humeral bristles lie along a straight or slightly curved line. In *Eusisyropa blanda* O.S., these three bristles are arranged in a distinct triangle. Therefore if it were placed in the Masicerina, it would run, in Mesnil's table (l.c. p. 295) to the section Phebelliariae and there to Myxexoristops Towns. (type *blondeli* R.-D.=*pexops* B.B.) from which, however, it differs rather markedly, the type of this genus having 5 strong humeral bristles, while *E. blanda* has only 3. However, in the classification developed by Mesnil, *blanda* does not belong in the sub-tribe Masicerina, because the width of the cheek is less than the distance from the base of the antenna to the eye, there are no black macrochaetae on the back of the head inside the marginal row, the hind tibiae are fairly distinctly ciliate and the occipital prolongation below the eye is parallel-sided—this being a consequence of the enlargement of the eye. On these characters, *blanda* falls into the sub-tribe Carceliina, running in Mesnil's table (l.c. p. 26) to the genus Carcelia, of which the type is *lucorum* Meig. (=*gnava* Meig.). Sellers had excluded *blanda* and allied species from

Carcelia since he defined this genus on the very narrow cheeks (not over 1/12 eye-height), together with the number of sternopleural machrochaetae (usually two) and the distinct ciliation of the hind tibiae (particularly in the male). Mesnil, however, does not accept this definition, because he considers that *Chaetomyia processioneae* Ratz. (commonly known in the past under the name of *Chaetomyia crassiseta* Rond.), is a true Carcelia, though the cheeks are relatively broad. "La dissection", he says (Notes sur les Carceliina (Dipt. Tachinidae) et révision des espèces d'Afrique; Rev. de Zool. et de Bot. africaines, Vol. XLIII, Fas. 1-2, 1950), "aussi bien que tout l'ensemble de la morphologie de cette espèce, démontrent qu'il s'âgit sans aucun doute d'un Carcelia s. str. bien proche de *C. excavata* Zett." In his Lindner monograph (p. 25) Mesnil says that the eggs of the Carceliines are elongate, with a pedicel at one end. This suggests that the pedicelled egg is a tribal characteristic. He adds, however, that *Theocarcelia incedens* Rond., (a species with bare eyes, sometimes called *pelmatoprocta* B.B., and formerly placed in the genus *Sturmia*) deposits larvae, which the present writer had in fact described in 1926 (l.c.) from a specimen determined by the late Dr. J. Villeneuve. Furthermore in answer to my enquiry about *Carcelia processioneae*, Dr. Mesnil has informed me that in fact, its egg is without a pedicel and that it deposits thin-shelled eggs containing larvae ready to hatch. This, he suggests, might be an adaptation to parasitism on the Procession caterpillars, difficult of access because they live in nests. The female parasite, according to information received by Mesnil, deposits its larvae on the webs and they then go in search of the host caterpillars. Thus the fact that *blanda* O.S., has microtype eggs and a cheek wider than Carcelia in the sense of Sellers, would not definitely exclude it from the Carceliina of Mesnil. Indeed, on the view expressed by Mesnil, the fact that it does not correspond to Carcelia in the sense of Sellers does not exclude it from this genus. Moreover, the fact that *processioneae* has broad cheeks and a thin-walled, non-pedicelled egg, containing a larva ready to hatch does not exclude it from Carcelia *s. str.* However, Mesnil does exclude *blanda* on the ground that it has the three posterior humeral bristles arranged in a very distinct triangle, whereas in Carcelia (or at least in the species I have been able to examine) the three bristles lie in a straight line. The neotropical species *Calocarcelia orellana* which has the humerals in a triangle is now excluded from Carcelia for the same reason, though in most respects it is very similar. I have examined the eggs of Calocarcelia, which are elongate, without a pedicel and contain larvae ready to hatch. Thus, to sum up, Mesnil, revising in Fasc. 172 of his monograph the views he held when he wrote Fasc. 153, includes both Calocarcelia and *Eusisyropa blanda* in the Carceliines.

*Zenillia libatrix* Panz., type of Zenillia R.-D. is placed by Mesnil, as already noted, in the sub-tribe Masicerina of the Goniini. This tribe is characterized as follows: ocellar bristles absent or directed forward; cheek as wide or wider than the distance from the eye to the base of the antenna; *not* possessing 5 humeral bristles, and *without* a hairy "barette" (the strip at the top of the hypopleuron) and long hairs along the ventral margins of the abdominal tergites (as in the Winthemiina); *not* having 4 humeral bristles, strongly convex squamae and a hairy "barrette" (as in the Ethyllina, e.g. *Paratryphera barbatula* Rond.=(*Exorista hirtipilis* Pand.)); the squamae regularly rounded, circular, with the inner margin convex, not lying along the margin of the scutellum; the facialia seldom high ciliate; the ♂ seldom with fine-haired patches on the under-side of the abdominal segments; first posterior cell not petiolate; bend of 4th vein nearer to the small cross-vein than to its own tip; frontal vitta bordered by fine cruciate hairs in addition to the frontal bristles; frontal

bristles piliform or lacking on the upper part of the front but bearing in this region reclinate inner orbital bristles.

The section Masicerariae, which contains *Zenillia*, is characterized as follows:—the cheeks are as wide or wider than the distance from the eye to the base of the antenna; the first abdominal segment is excavated to the posterior border; the three posterior humeral bristles lie along a slightly curved line; the apical scutellars are horizontal, only slightly elevated or absent; there are 2 or 3 reclinate frontals, the anterior the longer; the facialia are ciliate on little more than the lower half; the 5th abdominal tergite is not shortened but as long as the 4th tergite; the apical scutellars are strong or fairly strong and cruciate, the distance between them greater than the distance between the subapical and the basal of the same side.

We do not yet know the reproductive habits and the larval forms of all the genera and species grouped with *libatrix* and *blanda* in the classification of Mesnil. The early stages of *Zenillia libatrix* have been very completely described and figured by Dowden (Journ. Agr. Research, Vol. 48, No. 2, 1934). The anatomy of the primary larva has the general characteristics of those developing in microtype eggs. These larvae have, in general, complete bands of strong hooked spines on the anterior borders of the first three segments but often only a ventral row on the following segments; the antennae are minute, hemispherical, the felt-chambers of the posterior spiracles are short and small; the form of the vitelline membrane enclosing the embryo, is ovate, broadly rounded at the posterior end, pointed at the anterior end. However, the form of the buccopharyngeal armature, which is characteristic and rather unusual, is in *libatrix* (Fig. 17) quite different from that of *blanda*. It very closely resembles the armature of *Clemelis pullata* Meig., (Fig. 19) which has sometimes been assigned to Zenillia. It is also quite similar to the armature of *Cyzenis albicans* Fall (Fig. 18) classed by Schiner in Exorista "of authors". In his latest revision, Mesnil places Clemelis in the section Frontinariae and Cyzenis in the section Phryniariae. These two genera, like Zenillia, have the three basal humeral bristles arranged in a straight or curved line, not in a triangle. The later stages of Clemelis and Cyzenis, have not, so far as I am aware, been described. Those of *Zenillia libatrix*, however, differ as much from those of *E. blanda* as does the first stage.

Since *Zenillia libatrix*, *Clemelis pullata* and *Cyzenis albicans* are all placed by Mesnil in the same sub-tribe (Masicerina), the *sub-tribal* arrangement on adult characters corresponds, as far as these forms are concerned, to the arrangement that might be made on larval characters. However, *Frontina laeta* Meig., which is the type of the section Frontinariae, has a primary larva quite different from that of *Clemelis pullata;* and *Phryno vetula* Meig. the type of the section Phrynariae, has a primary larva still more different from that of *Cyzenis albicans* Fall; it is, in fact of the same general type as *Eusisyropa blanda*. *Masicera sylvatica* Fall., which belongs to the type genus of the Masicerariae, and produces microtype eggs, has a larva with a mouth-hook similar to that of *Blepharipoda scutellata* which is a Sturmiine. On the other hand, *Epicampocera succincta* Meig., which is in the Masicerariae, has an elongate, thin-shelled egg with a larva quite different from those produced by the species that oviposit on leaves. It is not a microtype egg.

Among the Nearctic species, the only species known to have a primary larva closely resembling that of *Zenillia libatrix* is *Aplomya caesar* Aldr., studied by Wishart (Can. Ent., Vol. 77, 1946) (Fig. 16). In his revision of Aplomya, Sellers defined the genus so that includes *mitis* Meig. (extremely close to *caesar*), *affinis* Fall. (extremely close to the Nearctic *estigmenensis*


Fig. 16, buccopharyngeal armature, *Aplomya caesar* Ald., Stage I (after Wishart); 17, same *Zenillia libatrix* Panz (after Dowden); 18, same, *Cyzenis albicans* Fall.; 19, same, *Clemelis pullata* Meig.

Sellers) and *confinis* Fall. (extremely close to *theclarum* Scudder). Sellers was aware that *confinis* is oviparous, depositing a large microtype egg, containing an embryo, while *affinis* is ovoviviparous. He did not know that *caesar* (and probably *mitis* also) deposits microtype eggs. Nevertheless he remarks that "Aplomya exhibits probably a more heterologous composition than any of the other genera proposed in this paper". According to Mesnil, *affinis* Fall. is a Hubneria, belonging, in the sub-tribe Masicerina, to the section Phryxariae; *mitis* runs in Mesnil's tables, to the Platymyiariae and to the genus Platymyia R.-D.; finally, *confinis* Fall. belongs to the Aplomyiariae, containing only *Aplomyia* (Mesnil accepts the emendation of Agassiz (1846); but Sellers does not refer to this and adopts the original spelling).

The case of *Eusisyropa blanda* O.S. is perhaps even more difficult. The Palaearctic species known to be most similar to *blanda* in the first larval stage is *Platymyia fimbriata* Meig., (Fig. 14) placed by the older authors, like *blanda*, in Exorista. *P. fimbriata* falls, in Mesnil's system, into the Platymyiariae which have the three basal humeral bristles lying along a curved line. It is in the sub-tribe Masicerina. On the other hand, another similar primary larva is that of *Sturmia bella* Meig., (Fig. 15) and another is the rather closely related *Blepharipoda scutellata* R.-D., while the larva of *Phryno vetula* as stated above, is of the same general type as *blanda*. In fact, the form of the primary larva of *blanda*, on the whole, indicates a closer relationship with *scutellata* and *bella* than with *libatrix*. Nevertheless, the principal character on which Mesnil relies to separate the Masicerina and the Sturmiina—the form of the squamae—enables us to place *fimbriata* without difficulty in the Masicerina while *bella* and *scutellata* clearly run to the Sturmiines. *E. blanda*, as we have seen, must go to the Carceliina. Among the Nearctic and Neotropical species, *Patelloa pachypyga* (Fig. 13) and *leucaniae*, *Euexorista futilis* and *Chaetogaedia ochriceps* (Fig. 12) though having eggs markedly different from the eggs of *blanda*, have larvae of the *blanda* type, though the proportions of the parts of the mouth-hook and the character of the spine bands differ.

Chaetogaedia, according to Mesnil, is a Sturmiine but Patelloa he thinks (in litt.) is a Masicerine. *E. futilis* according to Mesnil, is also a Masicerine belonging, like Patelloa, to the Phebellariae.

To sum up, the species known to have primary larvae of the *libatrix* type, fall within Mesnil's sub-tribe Masicerina, into the sections Mascerariae (*Zenillia libatrix*), Frontinariae (*Clemelis pullata*), Phryniariae (*Cyzenis*

*albicans*) and Platymyiariae (*Platymyia* (?) *caesar* Aldr.); the species with larvae resembling *Eusisyropa blanda*, fall partly into the Carceliines (*Eusisyropa*), partly into the Sturmiines (*Sturmia bella, Blepharipoda scutellata, Chaetogaedia ochriceps*), partly into the Masicerines (*Masicera sylvatica* going to the Masicerariae, *Phryno vetula* to the Phryniariae, *Platymyia fimbriata, Euexorista futilis*, and the Patelloas, to the Phebellariae).

It would, no doubt, be unwise to lay too much stress, with the inadequate knowledge we now possess, on some of the rather ill-defined resemblances and differences between larval forms. Nevertheless, it does appear, that with respect to reproductive habits and larval morphology some of Mesnil's groups of genera and even a genus (Carcelia) are still heterogeneous, as he himself recognizes. It would have been easy, by citing additional examples, to emphasize this fact.

If the groupings are meant to be merely practical, I mean, conveniences for the determination of species, this is not particularly important; but if they are meant to indicate the real affinities of natures, then they seem open to criticism. This matter requires more space for discussion than I can devote to it in this article. But it appears to me that the complex morphological, physiological and psychological coordinations evident in species that produce small eggs and deposit them on the food of the host are quite different from those we find in species that deposit large undeveloped eggs on the body of the host; and that such coordinations are more likely to indicate natural affinities—particularly within groups otherwise well-defined—than permutations and combinations of chaetotaxic and similar characters.

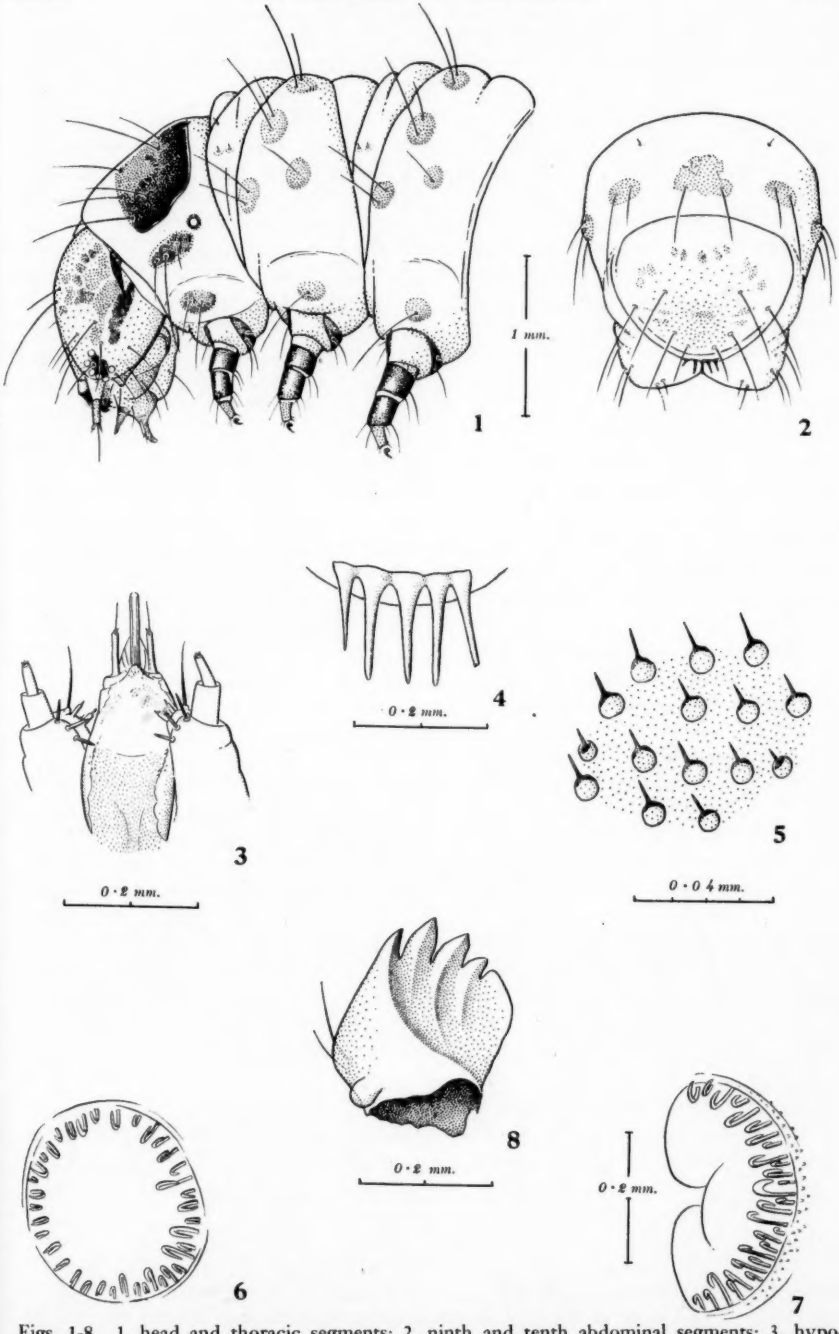
## The Last-instar Larva of *Epinotia mediovirida*na (Kft.) (Lepidoptera: Olethreutidae)[1]

*By* MARGARET RAE MACKAY[2]
Systematic Entomology Unit, Division of Entomology
Ottawa, Canada

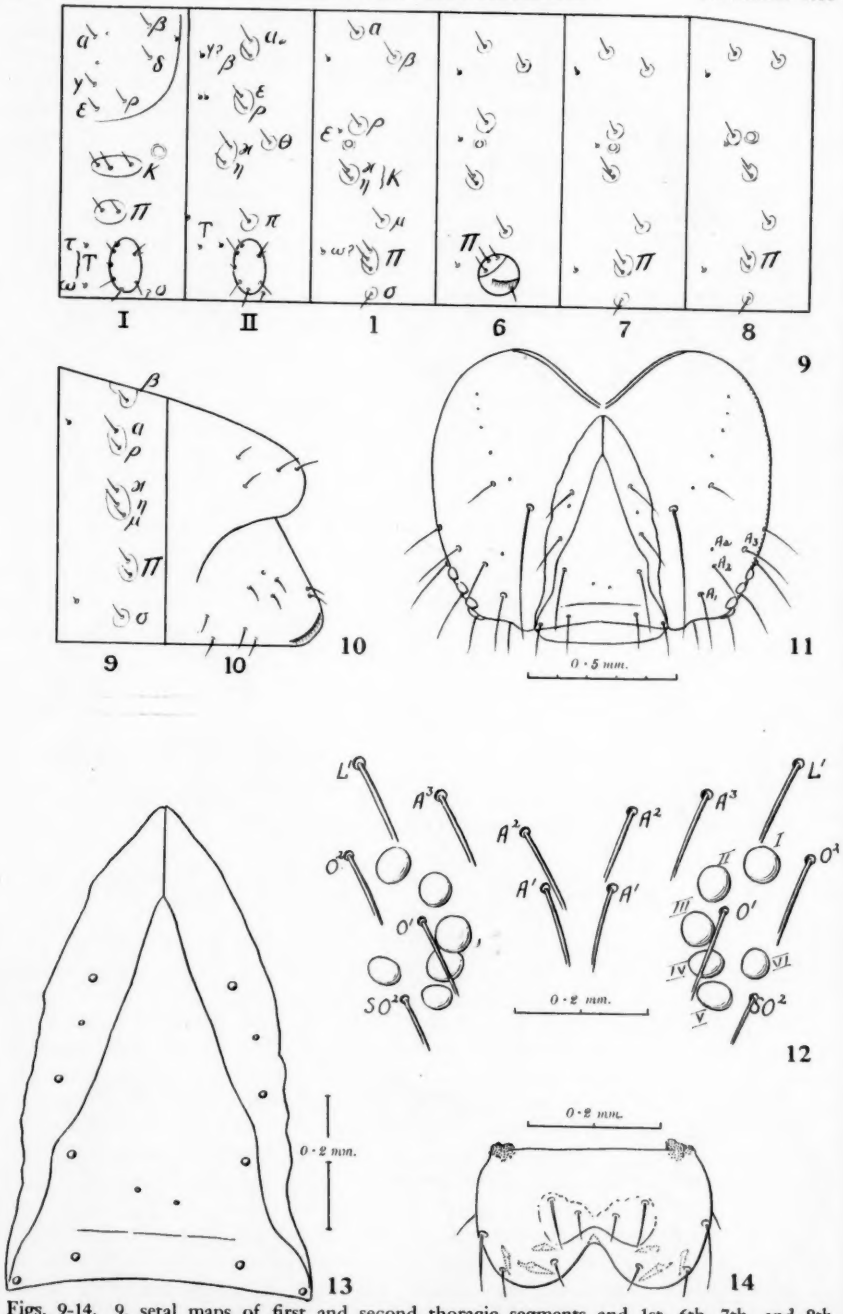
*Epinotia mediovirida*na (Kft.) (1908) is represented by very few specimens in any collection; there are two in the Canadian National Collection: a paratype (one of the six originally described) and a specimen from Tuxedo, N.Y. The species has been collected at Ottawa, which is its type locality, and in western Pennsylvania, but until now nothing has been known of its life history. During the summer of 1951, five last-instar larvae were collected from flowering raspberry, *Rubus odoratus* L., at Meach Lake, Que.; three were preserved and two reared to maturity. The following description has been obtained from the three preserved larvae and the two last-instar skins.

*Ultimate Instar* (Figs. 1 & 2).—Length: 10 to 12 mm.; average length of head: 0.93 mm.; average width of head: 1.15 mm.; average width of postclypeus: 0.46 mm.; average length of median dorsal line from anterior edge of postclypeus to termination of adfrontal sutures: 0.71 mm.; postclypeal index: 1.55. Integument (Fig. 5) spinulated; spinules slender, inconspicuous. Body whitish or greenish; setal bases on darker, sclerotized areas which are slightly raised and

[1]Contribution No. 3063, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.
[2]Agricultural Research Officer.




Figs. 1-8. 1, head and thoracic segments; 2, ninth and tenth abdominal segments; 3, hypopharynx, spinneret, and labial palps; 4, anal fork; 5, integument, highly magnified, showing spinules; 6, ventral proleg of sixth abdominal segment; 7, anal proleg; 8, mandible.




Figs. 9-14. 9, setal maps of first and second thoracic segments and 1st, 6th, 7th, and 8th abdominal segments; 10, setal maps of 9th and 10th abdominal segments; 11, setal map of head capsule; 12, relative positions of ocelli and surrounding setae; 13, postclypeal, frontal, and adfrontal areas; 14, labrum.

conspicuous in thoracic segments. Setae moderately long. Spiracles circular, dark-rimmed, small; areas surrounding spiracles also sclerotized and darker than body colour.

Head (Figs. 11, 12, 13) dark brown or tan. Anterior seta ($A_2$) about equidistant from $A_1$ and $A_3$. Lateral seta ($L_1$) about equidistant from ocellar seta 2 ($O_2$) and $A_3$. Ocellus II about equidistant from ocelli I and III, that distance being more or less equal to the radius of ocellus II. Median longitudinal width of postclypeus about equal to that of preclypeus. Width of labrum (Fig. 14) about one and three-quarters times length; sides of notch on anterior margin forming an angle of approximately 65°.

Mandible (Fig. 8) with five teeth, the first three sharply pointed, the fourth smaller but pointed, the fifth straight-edged; ridges from the first and third teeth to the dorsal area about the mandibular socket more pronounced than those from the second and fourth.

Spinneret (Fig. 3) as long as or longer than labial palp, length about six times width. Free margin of maxillary blade with several small, tooth-like processes which are indistinct, irregularly spaced, and variable in size; lobes and gorge armed with slender, minute spines; surface of lingua apparently granulated in some areas, otherwise bare.

Prothoracic shield (Fig. 1) dark brown, or tan darkening to dark brown posteriorly and laterally, with a pale medial dorsal line. Prothoracic Kappa and Pi groups of setae on slightly raised, dark-brown areas; middle seta of Kappa group ventrad to or in horizontal line with other two.

Setae (Figs. 9 and 10): Pi group on meso- and meta-thorax unisetose, on seventh abdominal segment bisetose, on eighth abdominal segment bisetose. Alpha associated with rho on segment nine. Minute primary setae present: one on caudal border of prothoracic shield posterior to beta and delta; one (probably gamma) anterior to beta on cephalic borders of mesothorax, metathorax, and abdominal segments one to nine; two in close association anterior to epsilon and rho on cephalic borders of meso- and meta-thorax; two of Tau group (possibly tau and omega) on prothorax; two or three of Tau group on meso- and meta-thorax; one of Tau group (possibly omega since tau is associated with the Pi group on abdominal segments) on each of the abdominal segments one to nine.

Anal shield (Fig. 2) of body colour. Prongs of anal fork (Fig. 4) usually five in number with bases not well developed; tips often blunted.

Thoracic legs dark brown. Ventral and anal prolegs of body colour; crotchets (Figs. 6 and 7) uniserial, more or less biordinal; crotchets of ventral proleg of sixth abdominal segment about 40 in number, those of anal proleg about 28.

*Host.—Rubus odoratus* L. (flowering raspberry). The larva crinkles the leaf of the host into a pouch and feeds within it.

*Remarks*—The larvae were collected on June 14, 1951; pupation occurred on June 27, and emergence of adults on July 17 and 20.

**Acknowledgment**

My sincere thanks to Dr. T. N. Freeman, Systematic Entomology Unit, Ottawa, who identified the reared adults and suggested the writing of this paper.

**Reference**

Kearfott, W. D. 1908. *J. New York Ent. Soc.* 16: 168.

# European Wireworms[1] in Canada with Particular Reference to Nova Scotian Infestations[2]

*By* D. C. EIDT[3]

Field Crop Insect Laboratory, Saskatoon, Sask.

## Introduction

Wireworms are considered among Europe's most destructive insects, particularly *Agriotes lineatus* (L.), *Agriotes obscurus* (L.), and *Agriotes sputator* (L.). These species have been introduced at certain isolated localities on the East Coast and the first two on the West Coast of Canada. They are known to be particularly widespread in Nova Scotia where they and native *Agriotes mancus* (Say) cause considerable crop damage.

The importance of these insects is apparent from the volume of literature that has been published in Europe. During the World Wars of 1914-18 and 1939-45, Britain became particularly concerned with wireworms when "ploughing up" campaigns led to severe injury to crops planted on newly broken land. France, Germany, Switzerland, Czechoslovakia, Russia, and Denmark have contributed to the literature on this common enemy.

The writer is indebted to Mr. W. J. Brown, Systematic Entomology, Division of Entomology, Ottawa, and Dr. K. M. King, Field Crop Insect Laboratory, Victoria, B.C., for their unpublished notes, and to Mr. C. J. S. Fox, Field Crop Insect Laboratory, Kentville, N.S., for invaluable assistance. He is also grateful for the advice and guidance given by his graduate committee, Dr. C. E. Atwood, Prof. A. W. Baker, Prof. H. W. Goble, Dr. F. P. Ide, and in particular Dr. W. E. Heming, Chairman of that group.

## History of the Infestations

Entomologists were not conscious of the existence of European elaterids on our coasts until 1939. In that year, W. J. Brown collected a single adult specimen of *A. sputator* in beach drift at Tabusintac, N.B., on June 20 (Brown, 1940).

Further examination of collections led Brown to discover five adults of *A. obscurus* in the Canadian National Collection, collected by R. P. Gorham in June 1922, and labelled "Kentville, N.S.". He found similarly labelled specimens in the collection of H. C. Fall. Mr. Gorham informed Mr. Brown, however, that they had been collected at Dartmouth. Further specimens were found in the Ulke collection at the Carnegie Museum, Pittsburg, labelled "N.S.", which were probably collected about 1859 (Banks *et al.*, 1910). In all of these collections *A. obscurus* was confused with *A. mancus*, a closely related native species (Brown, 1940).

In later trips to the East Coast, Brown collected adults of *A. sputator* at Sydney, N.S., in 1949. He found *A. obscurus* abundant around Dartmouth, N.S., in several localities as he expected, but also collected it at Sydney and Yarmouth. *A. lineatus* was first taken in 1947 at Yarmouth, N.S., and in 1949 at St. John's, Nfld. K. M. King found *A. obscurus* and *A. lineatus* at Cobble Hill, B.C., in 1949 (Brown, 1950a). *A. obscurus* was collected at Agassiz, B.C., where it was causing serious crop damage in 1952. (King *et al* 1952).

During the summer of 1950, the author collected a few adults of *A. sputator* at Digby and Weymouth, N.S. A number of larvae were collected, which were subsequently found to be *A. sputator*. Fourteen larvae of *A. obscurus*, deter-

[1] *Agriotes* spp., Coleoptera, Elateridae.

[2] Part of a thesis presented to the Faculties of the University of Toronto and the Ontario Agricultural College in partial fulfilment of the requirements for the Degree of Master of Science in Agriculture, and initiated as a project of the Nova Scotia Department of Agriculture and Marketing.

[3] Assistant Entomologist.

mined by the author, were collected near Lunenburg, N.S., later the same summer.

Larvae collected at various places in Nova Scotia in 1950, were reared in tile cages. Adults recovered from these cages in 1952 indicated a somewhat wider distribution than was formerly realized. *A. obscurus* adults were reared from larvae taken at Hall's Harbour, Weston, and Auburn in King's County, Falkland Ridge in Annapolis County, Lower West Pubnico in Yarmouth County, Lunenburg, and North Sydney. One *A. sputator* adult was reared from a larva taken at Forest Glade in Annapolis County.

Some entomologists (Brown, 1940 and 1950b), in dealing with introduced species of insects, have accepted the "ballast theory" of botanists. In early days, ships carrying cargoes of coal and wood from Eastern Canada to Europe carried a ballast of sand and soil on their return journeys. Rather than create shoals in their harbours, they deposited the ballast on the shore. As a result, the flora of Nova Scotia is rich in introduced plants, and doubtless many more were introduced that did not establish themselves.

A century ago Nova Scotia and New Brunswick consituted one of the shipping centres of the world, with wooden sailing ships calling at hundreds of small harbours along the coast. One such harbour is that at St. Andrew's, N.B. Brown (1940) quotes Fowler, who wrote in the 1901 Proceedings of the Natural History Association of Miramichi as follows: "In the early half of the century St. Andrew's was one of the busiest centres of commercial activity in the Province, and was especially distinguished for its export of lumber . . . The seeds of weeds brought in vessels from foreign lands secured a foothold on the vacant grounds . . . Probably no locality of equal area in Canada can boast of a larger percentage of foreign plants in its flora than that which flourishes on the streets and in the neighbourhood of St. Andrew's . . . of 32 species of Compositae collected, 20 were of foreign origin."

Of the known introduced beetles in Nova Scotia, most of them infest soil or feed on dung (Brown, 1940). This indicates that the "ballast theory" is applicable to many introduced insects as well as plants.

At Sydney, N.S., there are ballast heaps along the waterfront, within the urban area. It was here that Brown collected *A. obscurus* and *A. sputator*. This is a typical infested area, indicative of the validity of the "ballast theory".

At Sydney, the port is still in use. There are many other ports not in use today, and these have become non-commercial villages or have reverted to forest. The history of these old ports should be investigated, particularly those where infestations are known to exist. By this means, further infestations might be discovered, along with data pertinent to the infestations now known. An investigation of the potential of the insects as serious economic pests would certainly benefit from such historical data.

**Distribution of the European Species in Nova Scotia**

Although their distribution in Nova Scotia is now known to be more widespread, the introduced *Agriotes* spp. are restricted to small areas in the vicinity of old ports. They are confined by the forests, which act as natural barriers (Brown, 1950a), and workers who have studied them, with the exception of Fryer (1941), have reported that they do not fly.

At Dartmouth, for example, *A. obscurus* (L.) was easily collected by Brown at several locations, all within an area about 20 miles long and 5 miles wide. It could be collected at Lake Thomas where open fields exist. The forest borders on the highway for some distance towards Truro. On the other side of the forest, at Enfield, only *A. mancus* (Say) has been taken. The same is

true along the road to the Annapolis Valley, and the St. Margaret's Bay Road, which runs west to Lunenburg. *A. obscurus* was taken at Upper Sackville and Bedford, but only *A. mancus* was taken at Newport and Hubbards.

Around Yarmouth, *A. lineatus* (L.) occurs as far as Chebogue Point. At Tusket, and 9 miles north of Yarmouth at Port Maitland, it was not taken.

At Sydney, *A. obscurus* and *A. sputator* were collected by Brown. Both species are also known from North Sydney. *A. sputator* has been taken at Point Edward between Sydney and North Sydney. No other records of collections of *Agriotes* spp. are known from Cape Breton Island.

Competition between species is possibly an important factor (Brown, 1950a). *A. lineatus* and *A. obscurus* both occur at Yarmouth, and at Cobble Hill, B.C., but *A. obscurus* is scare at both places. *A. obscurus* was found to be abundant at Sydney and Dartmouth, where *A. lineatus* was not taken. At Digby and Weymouth only *A. sputator* was taken, although large numbers of larvae were collected. *A. mancus* is widespread throughout western Nova Scotia, but usually does not occur in areas where the introduced species are present. Exceptions are Upper Sackville, Weston, Hall's Harbour, Falkland Ridge, and Auburn, where both *A. mancus* and *A. obscurus* have been taken. An explanation for these distributional phenomena cannot be given.

The distribution of each species is listed below, along with the first date of collection for each locality and the name of the collector.

*Agriotes obscurus* (L.)

Nova Scotia.—"N.S." about 1859 (Henry Ulke); Dartmouth ("Kentville") 1922 (R. P. Gorham); Yarmouth, Cole Harbour, Eastern Passage 1947; Sydney, Cow Bay, Sackville, Lower Sackville, Upper Sackville, Waverley, Bedford, Lake Thomas 1949 (W. J. Brown); Westphal[4], Lunenburg, North Sydney, Falkland Ridge, Lower West Pubnico, Auburn, Hall's Harbour 1950 (D. C. Eidt).

British Columbia—Cobble Hill 1949, Agassiz 1952 (K. M. King).

*Agriotes lineatus* (L.)

Nova Scotia.—Yarmouth 1947 (W. J. Brown); Chebogue 1950 (D. C. Eidt).

Newfoundland.—St. John's 1949 (W. J. Brown).

British Columbia.—Cobble Hill 1949 (K. M. King).

*Agriotes sputator* (L.)

Nova Scotia.—Sydney 1949 (W. J. Brown); North Sydney, Point Edward, Marshalltown, Weymouth, New Edinburgh, Digby, Forest Glade 1950 (D. C. Eidt.

New Brunswick.—Tabusintac 1939 (W. J. Brown).

*A. obscurus* has spread more than the others as may be seen by examining its distribution. It has been found farther inland than *A. lineatus* or *A. sputator*.

It has taken 100 years for the species to spread as much as they have. Because Nova Scotia is joined to the mainland by a narrow isthmus and because the adults seldom, if ever, fly, the danger of a widespread North American distribution is not imminent.

If the European species were able to become established throughout the suitable North American range, it is possible that they might partially displace the native *A. mancus*. They may or may not be more injurious pests. If the attention they have been given in Europe is a good criterion, they could be very important on this continent.

Each of the infested areas in Nova Scotia is considered below:

*Dartmouth*

This is an area about 20 miles long and 5 miles wide, infested with *A. obscurus*. The larger portion of the area is in forest, with the bedrock exposed

[4]Based on larval records only.

Fig. 1. Map of Nova Scotia showing the distribution of *Agriotes* spp.

*Agriotes lineatus* (L.)—1. Chebogue, 2. Yarmouth. *Agriotes obscurus* (L.)—1. Cow Bay, 2. Eastern Passage, 3. Cole Harbour, 4. Dartmouth, 5. Waverley, 6. Bedford, 7. Lower Sackville, 8. Yarmouth, 9. Sydney, 10. Lunenburg, 11. North Sydney, 12. Lower West Pubnico, 13. Hall's Harbour, 14. Falkland Ridge, 15. Auburn, 16. Weston. *Agriotes sputator* (L.)—1. Sydney, 2. North Sydney, 3. New Edinburgh, 4. Weymouth, 5. Marshalltown, 6. Digby, 7. Forest Glade, 8. Point Edward. *Agriotes mancus* (Say)— 1. Tusket, 2. Auburn, 3. Barss Corners, 4. Weston, 5. Hall's Harbour, 6. Greenfield, 7. Kennetcook, 8. Newport, 9. Hubbards, 10. Upper Sackville, 11. Enfield, 12. Middle Musquodoboit, 13. New Glasgow, 14. Marshalltown, 15. Falkland Ridge.

in many places. Fields where *A. obscurus* causes considerable crop damage occur along the roads to Cow Bay, Cole Harbour, and Musquodoboit Harbour. Waverley and Bedford are separated from Dartmouth by forest and exposed bedrock with very few fields, and it is possible that they represent separate introductions. All of these points where the species has been collected are more or less isolated by forest, and the distribution may merely represent the amount of spread that has taken place since their introduction. Gorham (1923) noted that wireworms had been abundant in the Dartmouth area as long as the older residents could remember, and that they were first noticed near Preston. These wireworms, which Gorham found on both sides of Halifax Harbour, were probably all *A. obscurus*.

*Digby–Weymouth*

*A. sputator* has been taken at Digby, Marshalltown, Weymouth, and New Edinburgh. Two adult *Agriotes* spp. were also taken at Sandy Cove, about halfway down Digby Neck. Unfortunately, the latter specimens were lost before they could be identified, but they were smaller than *A. mancus* and were probably *A. sputator*.

Larvae of *A. sputator* were found to be causing crop damage at Marshalltown and New Edinburgh in 1950. The known infested area is about 20 miles long and 1 mile wide. C. J. S. Fox informs me that he observed heavy crop damage by unidentified *Agriotes* spp. at Centreville on Digby Neck in 1952.

The land is cleared along a narrow coastal strip extending almost continuously from Digby to 30 miles or more beyond Weymouth. It is therefore possible that *A. sputator* occurs along 50 miles of this coast, as well as on Digby Neck.

Between Digby and the Annapolis Valley there are comparatively few forest barriers, and it is possible that this species may invade that rich farming area in the near future. There is one isolated record of *A. sputator*, a reared adult, from a larva collected at Forest Glade in Annapolis County. Forest Glade is on The North Mountain, one mile or so inland, about 40 miles east of Digby, and separated from the Valley by considerable forest.

*Lunenburg*

This infestation is based on 14 larvae and 14 reared adults of *A. obscurus* collected in 1950. They were not abundant nor were they causing crop injury. In May, 1953, Fox (1953) found several infested fields. "The infestation extended at least from the Second Peninsula to two miles north of Lunenburg."

*Sydney*

*A. obscurus* and *A. sputator* were taken by Brown at Sydney in small, grassy patches along the waterfront. *A. obscurus* was the dominant species. Larvae taken at North Sydney were found to be *A. sputator*. Adults reared from larvae taken at North Sydney and Point Edward were *A. sputator*. Two *A. obscurus* larvae were found at North Sydney.

Truck crops at North Sydney suffered some damage from *A. sputator* in 1949 and 1950, as did crops at Point Edward.

The infested areas around Sydney are isolated by more than 100 miles of forest and one mile of sea, so there is little possibility that the infestation will spread.

*Yarmouth*

Brown collected *A. lineatus* in the grasslands which surround this town. He could not find it 9 miles north at Port Maitland, 6 miles west of Tusket, or

5 miles south at Chebogue Point. The writer found larvae in abundance about 2 miles south of Yarmouth at Chebogue, and reared adults from them. These were causing serious damage to potatoes and other crops as well. Farmers in the area had stopped commercial potato-growing because of them. *A. lineatus* has not been taken elsewhere in Nova Scotia, and there is little reason to expect it to spread very far or fast.

Brown also found *A. obscurus* adults in the grasslands surrounding Yarmouth. They did not occur in large numbers, *A. lineatus* being decidedly dominant.

*Pubnico*

One *A. obscurus* adult was reared from a collection of six larvae from Lower West Pubnico. This is probably a separate introduction. No serious wireworm damage has been recorded from the area.

*Berwick*

A few adults of *A. obscurus* were reared from larvae collected at Weston and Auburn near Berwick. These occurred with larger numbers of *A. mancus* in two seriously damaged fields, one in tomatoes and the other in oats. These appear to be recent infestations since *A. obscurus* had not been found there before, although much collecting has been done in the Annapolis Valley. These and the isolated record at Falkland Ridge are probably secondary infestations as the localities are all inland.

One *A. obscurus* adult reared from a larva from Hall's Harbour may represent a primary introduction. However, the greater proportion of the population there was *A. mancus* and the field was inland a mile or two in a predominantly forested area. No *Agriotes* spp. were found in the isthmus counties of Cumberland or Colchester, although much collecting was done there in 1950.

## Summary

*Agriotes lineatus* (L.), *A. obscurus* (L.), and *A. sputator* (L.) are among the most important agricultural insect pests in Europe. These species have been introduced on the East Coast and two of them on the West Coast of Canada. *Agriotes obscurus* has been in Nova Scotia at least since 1859.

The "ballast theory" of botanists is used to explain the mode of introduction. This theory states that certain organisms, associated with the soil, were introduced in ballast dumped by ships returning from Europe. The forests have acted as natural barriers, restricting the infestations to small areas about old ports. Competition between species may be important.

The known points of infestation are the vicinities of Dartmouth, Sydney, Yarmouth, Digby, Lunenburg, Pubnico, and Berwick in Nova Scotia; Tabusintac, New Brunswick; St. John's, Newfoundland; Cobble Hill and Agassiz, British Columbia.

## References

Balakowsky, A., and L. Mesnil. 1935. Les insects nuisibles aux plantes cultivées. 1: 754-788. Establishments Busson, Paris.

Banks, N., E. A. Schwarz, and H. L. Viereck. 1910. Resolutions on the death of Henry Ulke. *Proc. Ent. Soc. Washington.* 12: 105-111.

Brown, W. J. 1940. Notes on the distribution of some species of Coleoptera common to the European and North American continents. *Canadian Ent.* 72: 65-78.

Brown, W. J. 1950a. Private communication.

Brown, W. J. 1950b. The extralimital distribution of some species of Coleoptera. *Canadian Ent.* 82: 197-205.

Eidt, D. C. 1952. A study of introduced Elateridae in Nova Scotia. M.S.A. thesis presented to the Ontario Agricultural College and the University of Toronto.

Fox, C. J. S. 1951. An European wireworm (*Agriotes sputator* L.). *Canadian Insect Pest Review* 29: 222.

Fox, C. J. S. 1953. *Canadian Insect Pest Review* 31: 130.
Fox, C. J. S., and M. E. Neary. 1951. Insects affecting gardens and field crops in Nova Scotia. *Canadian Insect Pest Review* 30. 101.
Fryer, J. C. F. 1941. Time of flight in beetles of the genus *Agriotes*. *Ent. Mon. Mag.* 77: 280.
Gorham, R. P. 1924. Notes on *Agriotes mancus* Say at Dartmouth, N.S. *Proc. Acadian Ent. Soc. for 1923*, pp. 69-72.
King, K. M., R. Glendenning, and A. T. S. Wilkinson. 1952. A Wireworm (*Agriotes obscurus* L.). *Canadian Insect Pest Review* 30: 269.
MacNay, C. G. 1950. A summary of the more important insect infestations and occurrences in Canada in 1949. *80th Ann. Rept., Ent. Soc. Ontario for 1949*, pp. 57-77.

## Factors Affecting the Practical Employment of Systemic Insecticides. II[1].

*By* HUBERT MARTIN[2]

In the two years which have elapsed since I last wrote (Martin, 1950) of the potential uses of systemic insecticides, a deeper knowledge of the properties of these materials has become available to provide a sounder basis for their practical employment. A wide use of these materials has so far been hindered by scant information, particularly of the risks of harm following the consumption of treated food crops plants. Poisonous residues of the older insecticides which, by accident, remain on the plant surface are largely removed in the usual processes of preparation for the table such as washing, peeling, or discarding the outer leaves. These precautions fail with systemic compounds which not only pass into the plant tissue but which tend to accumulate in the storage organs and in the tenderer new growth, the very parts of the plant which serve for food. Clearly then an accurate and complete knowledge of the fate of the poisonous systemic insecticide must be available before its use on food crops can be recommended.

To date the greater part of the work on which this knowledge is based has been carried out on two of the systemic insecticides, the first, octamethylyprophosphoramide, which, by British Standards Specification 1831, has been christened schradan. The death of experimental animals treated with this compound may now be accepted as the result of an accumulation of acetylcholine, arising through an interference with the cholinesterases, the enzymes which normally hydrolize the toxic acetylcholine produced at the synapses of the parasympathetic nervous system. Yet in the Warburg respirometer, schradan reveals an inhibitory action on mammalian cholinesterases much less powerful than that of other toxic esters of phosphoric acid. It is apparent that schradan must undergo some change in the mammal to form an active inhibitor, a conversion which DuBois and his colleagues (1950) showed is accomplished in the liver. This observation has been verified by Gardiner and Kilby (1952) and by Cheng (1951), the latter showing that the liver is the main site of this reaction.

DuBois and his colleagues (1950) found that the conversion of schradan to an active inhibitor of cholinesterase is also effected by lettuce; Hall, Stohlman and Schechter (1951) found that the inhibitory effect of a chloroform extract of schradan-treated bean plants was some 700 times greater than that of the original schradan. Hartley and Heath (1951), though unable to reproduce the earlier evidence on lettuce by reason, they considered, of the instability of the active

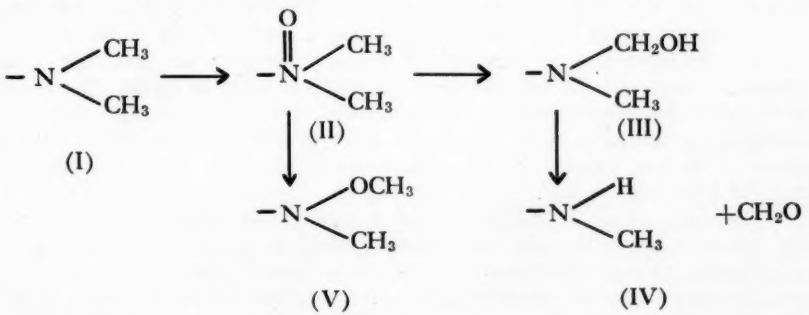
1Contribution Number 6 from the Science Service Laboratory, London, Ontario.
2Director, Science Service Laboratory, London, Ontario.

anticholinesterase, were able to demonstrate a decomposition of schradan in the actively-growing plant. Their technique is of elegant simplicity for they used radioactive schradan and the high partition coefficient of schradan between chloroform and aqueous alkali. The radioactivity of the chloroform extract of plant macerate fell in four weeks to 10 per cent of its original value in plants in vigorous growth.

Moreover, Hartley (1951) reported the work of his colleague P. O. Park who found that the gentle oxidation of schradan by dilute potassium permanganate buffered at pH 6.8 produced a chloroform-soluble product capable of a 50 per cent inhibition of the cholinesterase of human blood plasma at a concentration estimated at $6 \times 10^{-5}$ M. Schradan under similar conditions produced a 50 per cent inhibition at concentrations greater than $10^{-2}$ M. The rapid hydrolysis of this active compound under alkali conditions brings it within the close correlation frequently found between anticholinesterase activity and speed of alkaline hydrolysis, e.g., by Aldridge and Davison (1952) among the substituted phenyl diethyl phosphates.

The theoretical basis of this correlation is the hypothesis that the inactivation of the enzyme is the result of a phosphorylation of its protein. Experimental evidence of the phosphorylation of horse serum cholinesterase was obtained by Boursnell and Webb (1949). Hence, provided that the phosphoric ester is stable enough to water to reach the enzyme within the animal body, its activity as an inhibitor should be correlated with its ability to phosphorylate water, i.e., its speed of hydrolysis.

It may indeed be claimed that when a phosphoric acid ester shows *in vivo* anticholinesterase activity yet is stable to alkali there is a strong hint that the toxicity of the compound is due to a metabolic product. Moreover, the rapid breakdown of the active compound to non-toxic hydrolysis products is a reassuring safeguard against the hazards of cumulative mammalian toxicity. Results with radioactive schradan and of mammalian toxicity tests provide strong evidence that poison hazards arising through the use of schradan on food crops become negligible within a period of six weeks after its use, the one proviso being that the plant is in active growth when the schradan is applied.




(I) (II) (III) (V) (IV)

The pure chemical nature of the enzyme inhibitor produced by the oxidation of Schradan is not yet known, but Hartley (1951) postulated certain routes for the reaction of which the first step is an oxidation of one amide group (I) to the amide oxide (II). Migration of the oxygen follows to give the hydroxymethyl group (III) which decomposes to give the primary amine and formaldehyde. Alternatively, the amide oxide may be transformed to methoxyamide (V). Park (Hartley, 1951) showed that oxidation with permanganate required

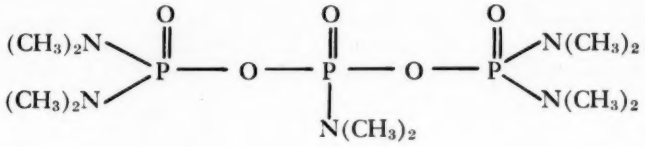
about one oxygen atom per molecule of schradan, which is the ratio required by the above equations.

Spencer, of the London laboratory, is also studying the decomposition of schradan in plants and has indications that gentle oxidation by chlorine leads to an evolution of formaldehyde which, on complete chlorination, amounts to approximately 4 moles per mole schradan. Hence the course of the reaction is via (IV) and not (V). In collaboration with O'Brien, he has demonstrated the anticholinesterase activity of the oxidized schradan and, with Smallman, he has also shown that the toxicity of the oxidized schradan to mosquito larvae is greater than that of schradan itself, though the rapid breakdown of the insecticide in aqueous solution has so far frustrated a precise assessment of its larvicidal potency.

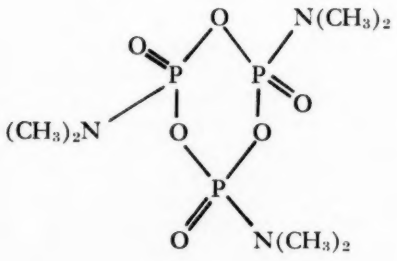
Whether or not the active inhibitor produced by the *in vitro* oxidation of schradan is the same as that produced in the liver of mammals remains to be proved. Hartley (1951) is of the opinion that the implications of the present scanty partition coefficient data are possibly otherwise. Nor is it yet proved that the courses of decomposition of schradan in mammal liver and in plants are identical. Certainly the speeds of decomposition are markedly different for whereas in the actively-growing plant about half the schradan is decomposed in some five weeks, in the animal the conversion is much more rapid. The concentration of the inhibitor in rabbit blood reached a maximum in some 40 minutes in Gardiner and Kilby's (1952) tests. The consequence of this relatively slow conversion of schradan in the plant and the rapid breakdown of the anticholinesterase so produced is that the concentration of the inhibitor in the plant can rarely be of significance as a cause of the systemic insecticidal activity of schradan. If schradan kills the insect it is presumably because the insect itself can accomplish the conversion to an anti-enzyme. It is now reasonably well-established that schradan-treated plants are toxic, in the practical sense, only to sap-sucking insects and mites (Martin, 1950). Lepidopterous larvae, for example, will consume relatively large amounts of schradan-treated foliage without any apparent effect, although presumably schradan reaches the intestinal tract in amounts comparable to those taken in by the aphid. Is the explanation that the susceptible insect possesses the enzyme necessary to convert schradan to an inhibitor, whereas such an enzyme is absent in the leaf-eating insect? Duspiva (1951) demonstrated that the cholinesterase activity of the nerve cord of schradan-treated fire bugs (probably *Pyrrhcoris apterus*) was less than in the untreated insect and that the enzyme activity of the brain of aphids was reduced in the schradan-poisoned insect. He concluded that enzyme systems capable of transforming schradan to an insecticide were present in these insects but are absent in the bee, the fly, and the potato beetle, for these insects tolerate large doses of schradan.

The enzymology of insects is at the moment in an interesting state of flux. The strong evidence that the mammalian toxicity of the phosphate esters is due to inhibition of a cholinesterase and the demonstration that insect nerve tissue contains cholinesterases naturally led to the conclusion that the toxic organophosphorus compounds function as anticholinesterases in the insect as they do in the mammal. Lord and Potter (1951) found however that preparations of whole *Tribolium castaneum* and of *Tenebrio molitor* did not hydrolyse acetylcholine though the aqueous ethanol extract of the latter larvae liberated *o*-nitrophenol from *o*-nitrophenyl acetate and hydrolysed ethyl butyrate. Morever, Hopf (1952) found that acetylcholine chloride and other choline esters were non-toxic when injected into the locust, nor was the toxicity of injected tetraethyl pyrophosphate affected by the injection of acetylcholine. For these and other

reasons he concluded that the phosphorus insecticides function as general esterase inhibitors and not specifically as anticholinesterase, and that acetylcholine has not the physiological role in insects that it plays in mammals. Yet the earlier work, particularly that of Metcalf and March (1950), leaves little doubt that the brain and nervous tissue of many insect species contain enzymes capable of the hydrolysis of acetylcholine. The simplest explanation of these apparent discrepancies is that there are interspecific differences in the esterase systems of insects, as indeed Metcalf and March (1950) established in the case of the specific cholinesterases of the brains of house flies and of honey bees. Such differences provide a second route by which selectivity of insecticidal action may be achieved; di*iso*propyl *p*-nitrophenyl thiophosphate is toxic to flies but not to bees because it inhibits the cholinesterases of fly brain but not those of bee brain; schradan is toxic to aphids but not to Lepidoptera, either because aphids possess, whereas the caterpillars do not possess, the enzyme required to convert schradan to an inhibitor, or because the anti-enzyme is ineffective in the caterpillar. The study of insect enzymology is likely to be a most fruitful source of the selective insecticides so necessary if chemical methods of crop protection are ever to be completely satisfactory.



(VI)



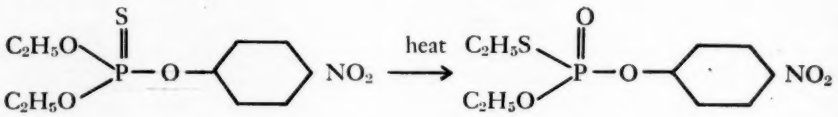
(VII)

Although it may now be accepted that the decomposition of schradan by actively-growing plants to non-poisonous compounds reduces, in some six weeks, spray residue hazards to negligible proportions, consideration must also be given to the hazards associated with the impurities likely to be present in commercial products for these rather than pure schradan will be the materials used in practice. Hartley and his co-workers (1951) have shown that the product obtained by the usual method of manufacture of schradan contains, in addition to octamethyl-pyrophosphoramide, a comparable amount of the amide of the next higher polyphosphoric acid (i.e., the penta(dimethylamide) of triphosphoric acid, VI). There are present also smaller amounts of higher polyphosphoramides too unstable in aqueous solution to give rise to residue hazards, and a tripolymer so stable that its anticholinesterase activity is doubtful. This compound has, because of this stability, been assigned to cyclic structure (VII). The only information

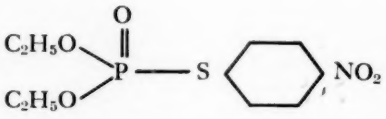
yet published (Hartley *et al.*, 1951) on the penta(dimethylamide) (VI) indicates that its insecticidal and systemic activities are comparable to those of schradan itself whereas it has a lower mammalian toxicity, the lethal oral dose to guinea pigs being at least five times as great as that of schradan (David *et al.*, 1951). The hazards of harmful residue in the harvested crop do not therefore appear to be greater with commercial than with pure schradan.

The second systemic insecticide I wish to discuss is a comparative newcomer, the ethylmercaptoethyl ester of diethyl thiophosphoric acid, reported to be the active component of "Systox". The published results indicate that this compound is a systemic insecticide more effective than schradan in the control of a wide range of insects, mites and nematodes. Confidential reports on chemical and enzyme studies of the residues remaining in plants after treatment are reassuring for little can be detected in plants harvested 90 days or so after treatment. There is however one complication which has to be considered in the interpretation of the results of these chemical or enzyme assays, a feature probably common to all esters of thiophosphoric acid.

This complication is best illustrated at present by the case of parathion, *O,O*-diethyl-*O*-*p*-nitrophenyl thiophosphate (VIII). It arises through the ease with which isomerization occurs in the thiophosphates. Thus parathion is converted on gentle warming to its *S*-ethyl isomer (IX), a compound which appears to play an important role in the toxicology of parathion. For the sake of completion, consideration of the corresponding *S*-phenyl isomer (X) is included.




(VIII) (IX)




(X)

Diggle and Gage (1951) have shown that parathion, if pure, is not particularly active as an anticholinesterase in *in vitro* tests. The *S*-ethyl and *S*-nitrophenyl isomers are, however, powerful inhibitors of cholinesterases, a finding confirmed by Aldridge and Barnes (1952), whose results are incorporated in Table 1. The earlier evidence of DuBois and his colleagues (1949) and of Aldridge (1950) that parathion is an inhibitor of cholinesterases has now been traced to the presence of the *S*-ethyl isomer, a source of error which I and my colleagues (Bennett, S. H. *et al.*, 1949) pointed out in 1949, though examples of this type of isomerization are to be found as far back as 1911 (Emmett and Jones, 1911). These early *in vitro* enzyme studies led to wrong conclusions because the results were interpreted without a precise knowledge of the chemical state of the thiophosphoric acid ester; similarly *in vitro* enzyme studies would yield misleading estimates of the toxicity hazards of treated crops.

TABLE 1

THE ANTICHOLINESTERASE ACTIVITY, MAMMALIAN TOXICITY AND INSECTICIDAL PROPERTIES OF THE ISOMERS OF PARATHION

| | Aldridge & Barnes (1952) | | Martin (1950) | |
|---|---|---|---|---|
| | Concentration giving 50% inhibition of sheep red cells at 37°C. | Approx. lethal dose by intravenous injection to male rats. mg./kg. | Lethal dose to *D. oleraceae* mg./g. | Relative potency to *C. granaria* |
| Parathion | $1.7 \times 10^{-4}$ M* | 3 | 4 | 1 |
| *S*-ethyl isomer | $2.5 \times 10^{-7}$ M | 1.2 | 15 | 0.06 |
| *S*-phenyl isomer | $2.8 \times 10^{-8}$ M *extrapolated > solubility at 37°C. | 0.5 | 40 | 0.04 |

*In vivo* studies of the isomers of parathion reveal curious differences between mammalian and insecticidal potency. Aldridge and Barnes (1952), in their revised figures for the toxicity of the isomers following intravenous injection of alcohol solution into male rats, show that the *S*-phenyl isomer > *S*-ethyl isomer > parathion. Yet in the insecticidal tests quoted by Martin (1950), Stringer found that both as stomach poisons to tomato moth larvae and as contact poisons to the granary weevil, the order of potency was reversed: parathion > *S*-ethyl isomer > *S*-phenyl isomer. Potter and his colleagues have, in the recently-issued Annual Report of the Rothamsted Experiment Station for 1951, initiated work on this apparent reversal. They confirm that insecticidal activity determined by contact effect on adult *Tribolium castaneum* is in the order: parathion > *S*-ethyl isomer > *S*-phenyl isomer. This wide divergence in the comparative insect and mammalian toxicities of the isomers renders insect bioassay of dubious value in the assessment of the hazards of mammalian toxicity arising through the use of parathion. The same doubts will arise in the examination of other esters of thiophosphoric acid if the latter reveal ready isomerization. The analysis of available samples of Systox indicates that some forty to fifty per cent of the thioester present is in the form of the isomer diethoxyphosphoric ester of 2-ethyl mercaptoethyl mercaptan. Hence a direct interpretation of insecticide tests to the hazards of mammalian toxicity is dangerous but negative results obtained both by *in vitro* enzyme studies and by insect tests give a reasonable assurance of freedom from poison hazards.

**Summary**

Expansion of the use of systemic insecticides awaits an assessment of the poison hazards of treated crop plants. The decomposition of schradan to non-poisonous products appears to be complete in six weeks in the actively-growing plant. Current evidence indicates that decomposition proceeds in the plant through an enzymatic oxidation to a readily-hydrolysed intermediate which is an active inhibitor of cholinesterases. The fate of schradan in the insect is unknown but the reasons for the differential insecticidal action of schradan are probably associated in a similar decomposition. The available evidence indicates also that ethylmercapto-ethyl diethyl thiophosphate disappears from the plant within a few weeks of application. The problem of residue determination is

here complicated by isomerization and, on the analogy of parathion, care is needed in the interpretation of bioassay and enzymatic methods of residue estimation.

## References


Aldridge, W. N. 1950. Some properties of specific cholinesterases with particular reference to the mechanism of inhibition by diethyl p-nitrophenyl thiophosphate (E 605) and analogues. *Biochem. J., 48.* 451.

Aldridge, W. N. and Barnes, J. M. 1952. Some problems in assessing the toxicity of the organophosphorus insecticides towards mammals. *Nature, 169.* 345.

Aldridge, W. N. and Davison, A. N. 1952. The inhibition of erythrocyte cholinesterase by thioesters of phosphoric acid I. *Biochem. J., 51,* 62.

Bennett, S. H., Martin, H., Stringer, A. and Woodcock D. 1949. The qualitative examination of insecticidal properties. Progress Report 1948. Ann. Rep. Long Ashton Res. Sta. 1948, p. 138.

Boursnell, J. C. and Webb, E. C. 1949. Reaction of esterases with radioactive di*iso*propyl fluorophosphonate. *Nature, 164.* 875.

Cheng, K. K. 1951. A technique for total hepatectomy in the rat and its effect on the toxicity of octamethylpyrophosphoramide. *Brit. J. Exp. Path., 32.* 444.

David, A., Hartley, G. S., Heath, D. F. and Pound, D. W. 1951. Studies on commercial octamethylpyrophosphoramide. II. *J. Sci. Food Agr., 2.* 310.

Diggle, W. M. and Gage, J. C. 1951. Cholinesterase inhibition *in vitro* by *O,O*-diethyl *O*-*p*-nitrophenyl thiophosphate. *Biochem. J., 49.* 491.

DuBois, K. P., Doull, J., Salerno, P. R. and Coon, J. M. 1949. Studies on the toxicity and mechanism of action of *p*-nitrophenyl diethyl thionophosphate. *J. Pharmacol. Expt. Therap., 95.* 79.

DuBois, K. P., Doull, J. and Coon, J. M. 1950. Studies on the toxicity and pharmacological action of octamethylpyrophosphoramide. *J. Pharmacol. Expt. Therap., 99.* 376.

Duspiva, F. 1951. The effect upon cholinesterase of certain phosphoric acid derivatives with insecticidal properties. *Rep. Berlin Dahlem Central Biol. Inst.*, p. 70.

Emmett, W. G. and Jones, H. O. 1911. Isomeric monothiophosphates. *J. Chem. Soc., 99.* 713.

Gardiner, J. E. and Kilby, D. A. 1952. Biochemistry of the organophosphorus insecticides. *Biochem. J., 51.* 78.

Hall, S. A., Stohlman, J. W. and Schechter, M. S. 1951. Colorimetric determination of octamethyl pyrophosphoramide. *Anal. Chem., 23.* 1866.

Hartley, G. S. 1951. First steps in the biochemistry of systemic insecticides. XV Int. Chemical Cong. New York. 1951.

Hartley, G. S. and Heath, D. F. 1951. Decomposition of radioactive octamethylpyrophosphoramide in living plants. *Nature, 167.* 816.

Hartley, G. S., Heath, D. F., Hulme, J. M., Pound, D. V. and Whittaker, M. 1951. Studies on commercial octamethylpyrophosphoramide. I. *J. Sci. Food Agric., 2.* 303.

Hopf, H. S. 1952. Studies on the mode of action of insecticides. I. *Ann. appl. Biol., 39.* 193.

Lord, K. A. and Potter, C. 1951. Studies on the mechanism of insecticidal action of organophosphorus compounds with particular reference to their anti-esterase activity. *Ann. Appl. Biol., 38.* 495.

Martin, H. 1950. Advances in chemical methods of crop protection. *J. Sci. Food Agric., 1.* 163.

Martin, H. 1950. Factors affecting the practical employment of systemic insecticides. *Canadian Ent., 82.* 247-9.

Metcalf, R. L. and March, R. B. 1950. Properties of acetylcholine esterases from the bee, the fly and the mouse and their relation to insecticide action. *J. Econ. Ent., 43.* 670.

# Note on Injury to Cucumber by the Tarnished Plant Bug, *Lygus lineolaris* P. de B. (Hemiptera: Miridae)

*By* D. G. HARCOURT

Vegetable Insect Section, Entomology Laboratory
Canada Department of Agriculture, Ottawa

During the third week of July, 1952, adults of the tarnished plant bug, *Lygus lineolaris* P. de B. [–*L. oblineatus* (Say)], suddenly became very numerous in a field of young cucumber, variety Straight Eight, near Ottawa, Ontario. The insect fed voraciously, attacking the tender, terminal growth of the vines. Little distortion of the foliage resulted, but numerous holes appeared in the leaves when they expanded.

Although the insect is known to feed on a wide variety of plants, a search of the literature revealed but a single reference to its causing damage to cucumber. Riley (1870) reported that it caused "injurious punctures" to late-planted cucumbers in a field near Chicago, Illinois.

The ultimate feeding injury (Fig. 1) closely resembled that of the striped cucumber beetle, *Acalymma vittata* (F.), and might easily have been mistaken for it. The holes in the leaves were irregular in shape and without necrotic margins. They varied from one to 10 millimeters in diameter, the mode being three millimeters.

The source of the infestation was an adjacent weedy field of clover and timothy that had been cut for hay during the second week of July. The population reached a peak of eight adults per plant on July 22. On the following day, 40 adults were captured and caged on healthy plants of Straight Eight cucumber in the greenhouses. Feeding injury was as described above.

Specimens of *L. lineolaris* were identified by Mr. E. H. N. Smith, Entomology Division, Ottawa.

## Reference

Riley, C. V. 1870. The tarnished plant-bug. *American Ent. and Bot.* 2: 291-293.

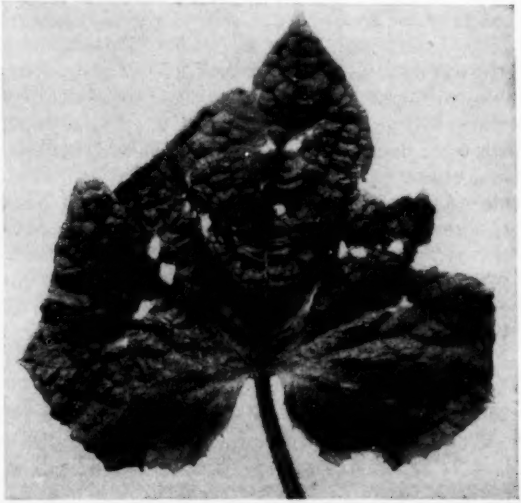


Fig. 1. Leaf of Straight Eight cucumber injured by feeding of adults of the tarnished plant bug.

# *Musca autumnalis* Deg. in North America (Diptera: Muscidae)

*By* J. R. Vockeroth
Systematic Entomology Unit, Entomology Division
Canada Department of Agriculture, Ottawa

*Musca domestica* L., the house fly, has hitherto been the only species of the genus definitely known to occur in North America. West (1951) wrote: "This paucity of species in the New World is somewhat strange . . . it would not be surprising if one or more additional representatives of the genus *Musca* should sooner or later put in their appearance on the American scene." An authentic record of a second species, *M. autumnalis* Deg. [=*M. corvina* Fab.], is therefore of considerable interest.

Five males and one female of this species, collected at Middleton, N.S., September 9, 1952, were recently submitted to the Division of Entomology for determination by Mr. M. E. Neary, Provincial Entomologist, Nova Scotia Department of Agriculture and Marketing, Truro. In his letter Mr. Neary stated that the flies had been abundant in a church in Middleton for more than a year, that they emerged from the walls of the church and died inside the building, and that each week hundreds of the flies were swept up. In a more extensive survey, Mr. V. R. Vickery, Department of Entomology, Nova Scotia Agricultural College, and Mr. C. J. S. Fox, Officer-in-Charge, Field Crop Insect Section, Science Service Laboratory, Kentville, N.S., later collected specimens of *autumnalis*, in buildings at Bridgetown, Lawrencetown, Margaretville, and Victoria Vale, N.S. Hence the species is definitely well established in one part of Nova Scotia at least. I wish to thank Mr. Neary for permission to publish the initial record, and Messrs. Vickery and Fox for submitting the additional specimens.

*M. autumnalis* has been recorded twice before from Nova Scotia, by Walker (1849, p. 900; 1871) as *corvina*. It has been assumed by later authors that Walker's specimens were actually of *domestica*; however, the species may have been present in Nova Scotia for over a century, as the Diptera of the area have been little collected and as *autumnalis* may readily be confused with *domestica* by casual observers. On the other hand, in 100 years the species would have been expected to spread to other areas, particularly to the northeastern United States, where collecting has been much more intensive. This would indicate a comparatively recent introduction. I should be very pleased to receive any information that may throw light on the history and distribution of the species in North America.[1]

The specimens were determined by comparison with material from England. Unlike *domestica*, *autumnalis* has the middle of the propleura bare, and the ridge above the thoracic squama (postalar declivity) bears a few fine bristles near its outer end. In the key to the genera of North American Muscidae given by Curran (1934), this species runs to *Orthellia;* the only North American species of *Orthellia*, however, is metallic green in colour. Specimens of *autumnalis* appear distinctly larger and heavier than those of *domestica*. Characters useful for separating the two species are as follows:—

1. Males ..... 2
   Females ..... 3
2. Eyes above separated by less than the width of the ocellar triangle; abdomen above with second and third tergites, except for median line, yellow to

[1]Shortly before this paper went to press, Mr. G. E. Shewell, Systematic Entomology Unit, Entomology Division, received the following note from Dr. H. C. Huckett, Associate Professor of Entomology, Long Island Vegetable Research Farm, who has kindly given permission for its publication. "Riverhead, N.Y., September 8, 1953. Happened to light on two specimens of *Musca autumnalis* today in my home. Your tip roused my curiosity. I cannot but think that the species has been overlooked." Editor.

orange-brown, remainder blackish ..... *autumnalis*
Eyes above separated by at least twice the width of the ocellar triangle; abdomen above usually with posterior half of first tergite and all of second tergite, except for median line, yellowish, remainder blackish; abdomen occasionally all dark ..... *domestica*

3. Orbital stripe grey pollinose, at least half as wide as the black median frontal stripe; abdomen dark above ..... *autumnalis*
Orbital stripe golden-yellow below, black above, at most one-third as wide as frontal stripe; abdomen as in male of *domestica*, darker specimens more frequent ..... *domestica*

*Musca autumnalis* is discussed briefly in numerous works on medical and household entomology, but the species is apparently of no great economic significance. The larvae live in cow-dung; the adults suck blood and other exudations from the surface of mammals, but cannot pierce the skin, and, like the adults of *Pollenia rudis* (Fab.), the cluster fly, they hibernate in large numbers in buildings. West (1951) gives the distribution of the typical subspecies as Europe, Palestine, Kashmir, and Shantung; other subspecies occur in Africa.

### References

Curran, C. H. 1934. The families and genera of North American Diptera. Ballou Press, N.Y.
Walker, F. 1849. List of the specimens of Dipterous Insects in the collection of the British Museum. Pt. 4. British Museum, London.
Walker, F. 1871. Notes on some insects of Nova Scotia and Canada. *Canadian Ent.* 3: 141-144.
West, F. 1951. The housefly. Comstock Publishing Co., Ithaca, N.Y.

## Aphid Parasites Collected in New Brunswick in 1950[1]

*By* M. E. MacGillivray[2] and P. B. Spicer[3]
Field Crop Insect Laboratory, Fredericton, N.B.

Since 1934, when studies of aphids infesting potatoes were begun in New Brunswick, it has been observed that a large number of potato aphids are attacked by parasites each season. More attention was given to parasitized aphids in 1950 than in previous years, in a study of parasitism as a factor in aphid control. In this paper are recorded the parasites reared from aphids collected on potatoes and other hosts in New Brunswick in 1950.

The majority of the aphids and parasites were collected by the writers. The methods of rearing, indexing, and preserving suggested by Smith (1944) were followed. In a few cases teneral material was obtained, the parasites having been killed too soon after emergence. Whenever possible, unparasitized aphids were also collected with parasitized forms for parasite-host identification. The aphids were identified by the senior author; the braconid parasites were identified by Mr. W. R. Mason, and the other parasites by Dr. O. Peck, Systematic Entomology Unit, Division of Entomology, Ottawa.

Twelve genera and five families of Hymenoptera (Muesebeck *et al.*, 1951) were represented in the collections. Some of the species are hyperparasites. The species are discussed under family, subfamily, and genus. Each species has been given a number, which is included in the list at the end of the paper.

[1]Contribution No. 3037, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.
[2]Technical Officer.
[3]Technical Officer, now retired.

**Family *Braconidae***
**Subfamily *Aphidiinae***

1. *Aphidius* (*Aphidius*) sp., ? *berberidis* Smith.—It was reared from *Aphis* sp., ? *neomexicana* (Ckll.) collected on *Ribes* sp., June 23, at Fredericton.

2. *Aphidius* (*Aphidius*) *nigripes* Ashmead.—Males and females of this species were reared only from aphids infesting *Solanum tuberosum* L. It was reared from *Aphis abbreviata* Patch collected August 24, at Woodstock; from *Macrosiphum solanifolii* (Ashm.) collected between July 7 and August 24 at Fredericton, Siegas, Tidehead, Escuminac, Maugerville, Arthurette, Woodstock, Doaktown, Jacquet River, and Burtts Corner; and from *Myzus persicae* (Sulz.) collected between July 25 and August 24 at Fredericton, Woodstock, and East Florenceville. This species parasitized more of *M. solanifolii* than of *M. persicae* or *A. abbreviata*

3. *Aphidius* (*Aphidius*) sp., ? *nigriteleus* Smith.—Two of the specimens were teneral. These parasites were reared from *Macrosiphum rosae* (L.) collected on *Rosa* sp., August 10, and from *Macrosiphum frigidicola* (G. & P.) on *Artemesia* sp., August 11, at Fredericton.

4. *Aphidius* (*Aphidius*) *ohioensis* Smith.—This species was reared from *Macrosiphum rudbeckiae* (Fitch) collected on *Solidago* sp., June 25 and 28, at Fredericton.

5. *Aphidius* (*Aphidius*) *pisivorus* Smith.—Males and females of this species were collected only from aphids infesting *Solanum tuberosum* L. Specimens were reared from *Aphis abbreviata* Patch and *Myzus persicae* (Sulz.) collected August 24 at Woodstock, and from *Macrosiphum solanifolii* (Ashm.) collected July 27 and August 24 at Woodstock, August 3 at Escuminac, and August 22 at East Florenceville.

6. *Aphidius* (*Aphidius*) *phorodontis* Ashmead.—This species was reared from *Phorodon menthae* (Buckt.) collected on *Mentha* sp., August 16; from *Liosomaphis berberidis* (Kltb.) on *Berberis* sp., September 7; and from *Calaphis betulaecolens* (Fitch) on *Betula alba* L., at Fredericton.

7. *Aphidius* (*Aphidius*) *polygonaphis* (Fitch).—This species was reared from *Macrosiphum ambrosiae* (Thos.) collected on *Solidago* sp., July 20, at Fredericton.

8. *Aphidius* (*Aphidius*) *pterocommae* Ashmead.—Several specimens of this species were reared from *Clavigerus populifoliae* (Fitch) collected on *Populus grandidentata* Michx., July 12, at Noonan.

9. *Aphidius* (*Aphidius*) *ribis* Haliday.—This species was reared from *Capitophorus ribis* (L.) collected on *Ribes* sp., June 23 and July 4, at Fredericton.

10. *Aphidius* (*Aphidius*) *rosae* Haliday.—A male of this species was reared from *Amphorophora rubicola* (Oest.) collected on *Rubus* sp., July 27, at Fredericton. Several males and females were also reared from *Macrosiphum solanifolii* (Ashm.) and *Myzus persicae* (Sulz.) collected on *Solanum tuberosum* L. between July 14 and August 24, at Fredericton, Woodstock, Keswick, Arthurette, Tidehead, Escuminac, Richibucto, Jacquet River, Siegas, East Florenceville, and Burtts Corner.

11. *Aphidius* (*Aphidius*) sp.—Specimens of the genus not determined to species were reared from *Liosomaphis berberidis* (Kltb.) collected on *Berberis* sp. and from *Capitophorus potentillae* (Wlkr.) collected on *Rosa* sp., July 4; from *Cavariella aegopodii* (Scop.) collected on *Daucus carota* L., August 10; and from *Amphorophora cosmopolitana* Mason collected on *Sonchus arvensis* L., August 28, at Fredericton. Specimens were also reared from *Aphis rumicis* L.

collected on *Chenopodium album* L., July 14, at Nashwaaksis; and from *Macrosiphum solanifolii* (Ashm.) and *Myzus persicae* (Sulz.) collected on *Solanum tuberosum* L., July 27 and August 24, at Woodstock.

12. *Aphidius* (*Lysaphidus*) *adelocarinus* Smith.—This species was reared from *Aphis helianthi* Monell collected on *Cornus stolonifera* Michx., June 22, at Tidehead.

13. *Aphidius* (*Lysaphidus*) *rosaphidis* Smith.—This species was reared from *Capitophorus potentillae* (Wlkr.) collected on *Fragaria* sp., August 5, at Fredericton.

14. *Aphidius* (*Lysiphlebus*) *testaceipes* (Cresson).—This species was reared from *Aphis helianthi* Monell collected on *Cornus stolonifera* Michx., June 22, at Tidehead and July 18, at Fredericton; from *Capitophorus ribis* (L.) and *Aphis* sp., ? *neomexicana* (Ckll.) collected on *Ribes* sp., June 23, at Fredericton; from *Aphis rumicis* L. collected on *Chenopodium album* L., July 14, at Nashwaaksis and August 23, at Maugerville, and on *Arctium minus* (Hill) Bernh., July 10, at Fredericton; from *Aphis abbreviata* Patch collected on *Rhamnus cathartica* L., July 15, at Fredericton; and from *Aphis* sp. collected on *Bidens* sp., July 27, at Fredericton.

15. *Aphidius* (*Protaphidius*) sp., ? *californicus* Ashmead.—This species was reared from *Eulachnus agilis* (Kltb.) collected on *Pinus sylvestris* L., September 8, at Fredericton.

16. *Diaeretus chenopodiaphidis* (Ashmead).—This species was reared from *Hyalopterus atriplicis* (L.) and *Aphis rumicis* L. collected on *Chenopodium album* L., July 19, at Woodstock.

17. *Diaeretus rapae* (Curtis).—This species is commonly found in the greenhouse parasitizing *Myzus persicae* (Sulz.). It was reared from *M. persicae* collected on *Solanum tuberosum* L. and *Brassica napus* L. from May to August at Fredericton, Woodstock, East Florenceville, and Arthurette. It was also reared from *Aphis abbreviata* Patch collected on *Solanum tuberosum*, July 26, at Tidehead and from *Calaphis betulaecolens* (Fitch) and *Euceraphis betulae* (Koch) collected on *Betula* sp., September 7 and October 3, at Fredericton.

18. *Diaeretus* sp., ? *salicaphis* (Fitch).—It was reared from *Clavigerus populifoliae* (Fitch) collected on *Populus grandidentata* Michx., July 12, at Noonan. It was also reared from *Aphis helianthi* Monell collected on *Cornus stolonifera* Michx., June 22, at Tidehead.

19. *Diaeretus* sp.—Several undetermined species of *Diaeretus* were reared from *Cavariella aegopodii* (Scop.) collected on *Daucus carota* L., August 5 and 10, at Fredericton.

20. *Ephedrus incompletus* (Provancher).—This species was reared from *Macrosiphum agrimoniella* (Ckll.) collected on *Agrimonia* sp., July 10, at Fredericton.

21. *Praon aguti* Smith.—This species was reared from *Macrosiphum solanifolii* (Ashm.) collected on *Solanum tuberosum* L. between July 27 and August 24 at Woodstock; from *Myzus persicae* (Sulz.) collected on *Solanum tuberosum* L. between August 9 and 24 at Fredericton, Pokiok, East Florenceville, and Woodstock; and from *Macrosiphum frigidicola* (G. & P.) collected on *Artemsia* sp., August 11, at Fredericton.

22. *Praon occidentalis* Baker.—This species was reared from *Macrosiphum solanifolii* (Ashm.) collected on *Solanum tuberosum* L. between August 9 and 24, at Fredericton, Jacquet River, Pokiok, and Woodstock; and from *Myzus persicae* (Sulz.) collected on *Solanum tuberosum* L., August 24, at Woodstock.

23. *Praon simulans* (Provancher).—This species was reared from *Macrosiphum solanifolii* (Ashm.) collected on *Solanum tuberosum* L., July 25, at Pokiok and August 9 at Fredericton; and collected on *Capsella bursa-pastoris* (L.) Medic., August 4, at Pokiok. It was reared also from *Macrosiphum albifrons* Essig collected on *Lupinus* sp., July 25, and from *Macrosiphum pisi* (Kltb.) collected on *Lathyrus odoratus* L., August 23, at Fredericton.

24. *Praon* sp.—Unfortunately males of this genus cannot be identified without associated females. Males were reared from *Macrosiphum solanifolii* (Ashm.), *Myzus persicae* (Sulz.), and *Aphis abbreviata* Patch collected on *Solanum tuberosum* L. between July 26 and August 25 at Fredericton, Woodstock, Maugerville, Escuminac, Jacquet River, Richibucto, Guercheville, and Tidehead. Males were also reared from *Amphorophora cosmopolitana* Mason collected on *Sonchus arvensis* L., August 28, and from *Macrosiphum solanifolii* (Ashm.) collected on *Citrullus vulgaris* Schrad., August 5, at Fredericton. It was noted than many of these parasites emerged from the aphids at the dorsal area of the head.

25. *Trioxys* (*Trioxys*) sp.—Specimens of this genus were reared from *Aphis pomi* Deg. collected on *Malus pumila* Mill., June 29, and from *Calaphis betulaecolens* (Fitch) collected on *Betula* sp., September 7, at Fredericton.

### Family *Encyrtidae*
### Subfamily *Encyrtinae*

26. *Bothriothorax noveboracensis* Howard.—A female of this species was reared from *Clavigerus bicolor* (Oest.) collected on *Salix babylonica* L., August 18, at Fredericton. Most species of this genus are syrphid parasites (Peck, 1951, pp. 484-485).

### Family *Pteromalidae*
### Subfamily *Sphegigasterinae*

27. *Asaphes lucens* (Provancher).—Both males and females of this species have been reared from a wide range of hosts. They were reared from *Macrosiphum solanifolii* (Ashm.) collected at Arthurette, Tidehead, Pokiok, Fredericton, Woodstock, Escuminac, Richibucto, and Lincoln; and from *Myzus solani* (Kltb.) collected at Pokiok, Tidehead, and Fredericton on *Solanum tuberosum* L. They were reared also from *Aphis rumicis* L. collected on *Viburnum* sp.; from *Amphorophora cosmopolitana* Mason collected on *Sonchus arvensis* L.; from *Calaphis betulaecolens* (Fitch) collected on *Betula* sp.; from *Cavariella aegopodii* (Scop.) collected on *Daucus carota* L.; from *Macrosiphum pisi* (Kltb.) collected on *Lathyrus odoratus* L.; from *Macrosiphum rudbeckiae* (Fitch) and *Macrosiphum* sp. collected on *Solidago* sp.; from *Neothomasia negundinis* (Thos.) collected on *Acer negundo* L.; from *Myzus persicae* (Sulz.) collected on *Brassica napus* L. at Fredericton; and from *Myzus porosus* Sanderson collected on *Fragaria* sp. at MacDonald's Corner. All collections were made in August and September.

28. *Asaphes* sp.—Undetermined species of this genus were reared from *Liosomaphis berberidis* (Kltb.) collected on *Berberis* sp., June 13; from *Eulachnus agilis* (Kltb.) collected on *Pinus sylvestris* L., October 4; and from *Myzus persicae* (Sulz.) collected on *Solanum tuberosum* L., August 9, all at Fredericton. Specimens were also reared from *Macrosiphum solanifolii* (Ashm.) collected on *Solanum tuberosum* L. at Woodstock, August 24.

29. *Coruna* sp., ? *clavata* Walker.—Females of this species were reared from *Macrosiphum solanifolii* (Ashm.) collected on *Solanum tuberosum* L., August 9, at Fredericton and Woodstock. Males were reared from *Myzus persicae* (Sulz.) collected on *Solanum tuberosum* L., August 9 and 19, at Fredericton.

Dr. Peck (in litt.) has informed us that this genus has not been recorded previously from North America and that in Europe the genus has been reported several times as hyperparasitic on aphids, which were not recorded as potato feeders.

30. *Euneura lachni* (Ashmead).—This species was reared from *Macrosiphum solanifolii* (Ashm.) collected on *Solanum tuberosum* L., August 24, at Woodstock; and from *Macrosiphum rudbeckiae* (Fitch) collected on *Rudbeckia* sp., August 2, at Fredericton.

31. *Pachyneuron altiscutum* Howard.—Males and females of this species were reared from *Macrosiphum solanifolii* (Ashm.) collected on *Solanum tuberosum* L., August 24, at Woodstock. A female was reared from *Macrosiphum pisi* (Kltb.) collected on *Caragana* sp., August 28, at Fredericton.

32. *Pachyneuron siphonophorae* (Ashmead).—Several males and females of this species were reared from *Macrosiphum solanifolii* (Ashm.) and *Myzus persicae* (Sulz.) colelcted on *Solanum tuberosum* L., August 24, at Woodstock; and from *Aphis pomi* (Deg.) collected on *Malus pumila* Mill., June 29; from *Macrosiphum erigeronensis* (Thos.) collected on *Solidago* sp., August 4; from *Macrosiphum frigidicola* (G. & P.), collected on *Artemesia* sp., August 10; from *M. persicae* (Sulz.) collected on *Brassica napus* L., September 7, all at Fredericton. Females were reared from *Hyalopterus atriplicis* L. collected on *Chenopodium album* L., August 4, at Keswick, and from *Cavariella capreae* (Fabr.) collected on *Daucus carota* L., August 10, at Maugerville.

### Family *Cynipidae*
### Subfamily *Charipinae*

33. *Alloxysta* sp.—Only females of this genus were reared. Specimens without scutellar fovea were reared from *Neothomasia negundinis* (Thos.) collected on *Acer negundo* L., August 5, and from aphids collected on *Betula* sp., October 10, at Fredericton. Females with scutellar fovea were reared from *Myzus persicae* (Sulz.) collected on *Solanum tuberosum* L., August 9, at Lincoln, and from *Aphis rumicis* L. and *Macrosiphum solanifolii* (Ashm.) collected on *Tropaeolum* sp., August 4, at Pokiok.

34. *Charips* sp.—Females and males of this genus with the first funicle long were reared from *Macrosiphum solanifolii* (Ashm.) collected on *Solanum tuberosum* L., July 27 and August 27 at Woodstock, and August 2 at Tidehead. Males and females with the first funicle short were reared from *Kakimia essigi* (G. & P.) collected on *Aquilegia vulgaris* L., July 25; from *Macrosiphum rudbeckiae* (Fitch) collected on *Solidago* sp., July 25 and August 2; from *Phorodon menthae* (Buckt.) collected on *Mentha* sp., August 16; from *Amphorophora rubicola* (Oest.) collected on *Rubus* sp., August 4; from *Capitophorus* sp. collected on *Solanum tuberosum* L., August 9; from *Myzus* sp. collected on *Chenopodium album* L., September 7; and from *Aphis abbreviata* Patch collected on *Zinnia* sp., September 14, all at Fredericton. Specimens with the first funicle short were reared from *Macrosiphum erigeronensis* (Thos.) collected on *Solidago* sp., August 4, at Pokiok, and from *Macrosiphum solanifolii* (Ashm.) collected on *Solanum tuberosum* L., August 24, at Woodstock.

The Charipinae are hyperparasitic. The species are not well known either taxonomically or biologically.

### Family *Ceraphronidae*

35. *Lygocerus* sp., possibly *niger* (Howard).—Males and females were reared from *Macrosiphum solanifolii* (Ashm.) collected on *Solanum tuberosum* L., August 2 and 16, at Tidehead; August 3 and 10 at Richibucto; August 8 and 15

at Pokiok; August 9 at Jacquet River and Fredericton; and August 24 at Woodstock. Males and females were also reared from *Macrosiphum rosae* (L.) collected on *Rosa* sp., August 10; from *Macrosiphum pisi* (Kltb.) collected on *Caragana* sp., August 28, at Fredericton; and from *Myzus persicae* (Sulz.) collected from *Solanum tuberosum* L., September 12, at Woodstock.

36. *Lygocerus* sp., not *niger* (Howard).—Males were reared from *Macrosiphum solanifolii* (Ashm.) collected on *Solanum tuberosum* L., August 15, at Escuminac and from *Myzus persicae* (Sulz.) collected on *Zinnia* sp., August 28, at Fredericton.

Some species of this genus appear to be hyperparasites.

**Aphids and Associated Parasites Collected in 1950**

| Host and Parasite | Reference No. |
|---|---|
| *Amphorophora cosmopolitana* Mason | |
| *Aphidius* (*Aphidius*) sp. | 11 |
| *Asaphes lucens* (Provancher) | 27 |
| *Praon* sp. | 24 |
| *Amphorophora rubicola* (Oestlund) | |
| *Aphidius* (*Aphidius*) *rosae* Haliday | 10 |
| *Charips* sp. | 34 |
| *Aphis abbreviata* Patch | |
| *Aphidius* (*Aphidius*) *nigripes* (Ashmead) | 2 |
| *Aphidius* (*Aphidius*) *pisivorus* Smith | 5 |
| *Aphidius* (*Lysiphlebus*) *testaceipes* (Cresson) | 14 |
| *Charips* sp. | 34 |
| *Diaeretus rapae* (Curtis) | 17 |
| *Praon* sp. | 24 |
| *Aphis helianthi* Monell | |
| *Aphidius* (*Lysaphidus*) *adelocarinus* Smith | 12 |
| *Aphidius* (*Lysiphlebus*) *testaceipes* (Cresson) | 14 |
| *Diaeretus* sp., ? *salicaphis* (Fitch) | 18 |
| *Aphis* sp., ? *neomexicana* (Cockerell) | |
| *Aphidius* (*Aphidius*) sp., ? *berberidis* Smith | 1 |
| *Aphidius* (*Lysiphlebus*) *testaceipes* (Cresson) | 14 |
| *Aphis pomi* DeGeer | |
| *Pachyneuron siphonophorae* (Ashmead) | 32 |
| *Trioxys* (*Trioxys*) sp. | 25 |
| *Aphis rumicis* Linnaeus | |
| *Alloxysta* sp. | 33 |
| *Aphidius* (*Aphidius*) sp. | 11 |
| *Aphidius* (*Lysiphlebus*) *testaceipes* (Cresson) | 14 |
| *Asaphes lucens* (Provancher) | 27 |
| *Diaeretus chenopodiaphidis* (Ashmead) | 16 |
| *Aphis* sp. | |
| *Aphidius* (*Lysiphlebus*) *testaceipes* (Cresson) | 14 |
| *Calaphis betulaecolens* (Fitch) | |
| *Aphidius* (*Aphidius*) *phorodontis* Ashmead | 6 |
| *Asaphes lucens* (Provancher) | 27 |
| *Diaeretus rapae* (Curtis) | 17 |
| *Trioxys* (*Trioxys*) sp. | 25 |

*Phorodon menthae* (Buckton)
*Aphidius* (*Aphidius*) *phorodontis* Ashmead ..... 6
*Charips* sp. ..... 34

**References**

Muesebeck, C. F. W., K. V. Krombein, and H. K. Townes. 1951. Hymenoptera of America north of Mexico. Synoptic catalogue. *U.S. Dept. Agr., Agr. Monogr.* 2.

Peck, O. 1951. Superfamily Chalicidoidea. *In* Hymenoptera of America north of Mexico. Synoptic catalogue, by C. F. W. Muesebeck, K. V. Krombein, and H. K. Townes, pp. 410-594. *U.S. Dept. Agr., Agr. Monogr.* 2.

Smith, C. F. 1944. The Aphidiinae of North America (Braconidae: Hymenoptera). *Ohio State Univ. Contr. in Zool. and Ent.* 6.

## A New Species of Cinara (Homoptera: Aphididae) from Saskatchewan[1]

*By* G. A. Bradley[2]
Laboratory of Forest Biology, Indian Head, Saskatchewan

***Cinara obscura* n. sp.**

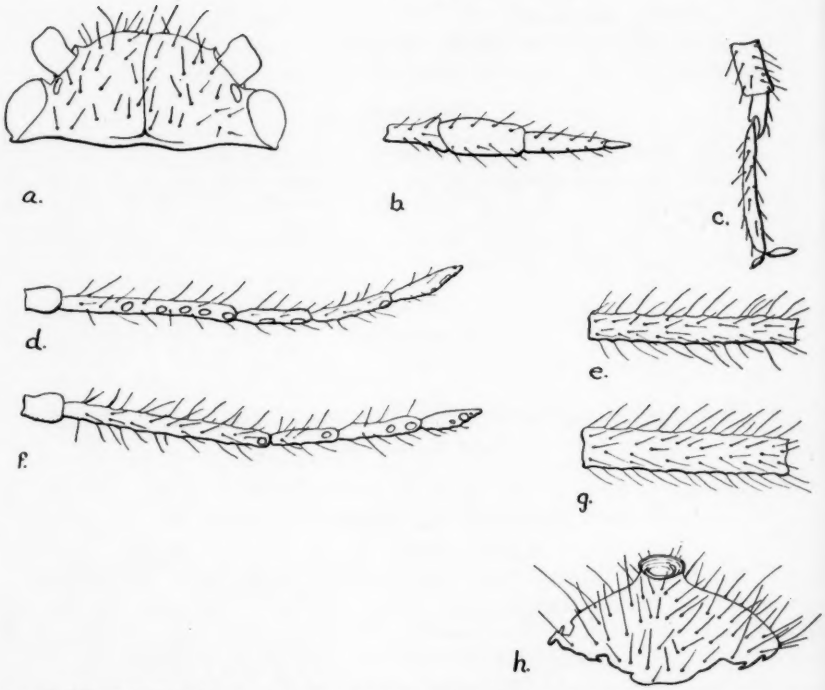
Alate Viviparous Female: Body, legs, antennae, and cornicles bearing moderately long setae, but not conspicuously hairy. In cleared specimens, the following parts are dusky brown: head, thorax, cornicles, cauda, coxae, rostrum and bases of the femora; a very short basal portion, and the distal half of the tibiae; tarsi; antennal joints I, II, VI, and distal portions of III, IV and V. As in many other species in this genus, there are four longitudinal rows of small brown spots dorsally on the abdomen, extending from the thorax to the area between the cornicles, and two rows laterally, one on each side, composed of somewhat larger brown areas around the spiracles. Remainder of body and appendages clear. Wings hyaline, with media faint and twice-branched. Antennal sensoria, III 5(4-6); IV 2(1-2); V 2. Ocular tubercles present.

Measurements: (millimetres) Body length, 2.49; width, 1.16. Antennae, length 1.06; joints, III .40(.35-.40); IV .14(.13-.14); V .19(.16-.19); VI .15 (.13-.15). Setae on antennae long, about 1½x diameter of segment. Rostrum extending as far as the cornicles; segments, III .19(.17-.19); IV .16(.14-.16); V .07(.06-.07). Length of hind tibia, 1.53(1.29-1.53). Hind tarsi, segments I .09(.08-.09); II .27(.25-.27). Setae on hind tibiae .10(.08-.10), 1½x diameter of segment. Cornicle base .36(.32-.39).

Apterous Viviparous Female: Similar to alate in colour and general appearance. Antennal sensoria, III 2(1-2); IV 1(1-3); V 2. Ocular tubercles present; no mesosternal tubercle. Body, legs, antennae, and cornicles bearing numerous setae. Sensoria, III 2(1-2); IV 1(1-3); V 2.

Measurements: Body length, 2.49; width, 1.66. Antennae: length .98; joints, III .36(.36-.43); IV .14(.13-.17); V .15(.15-.18); VI .13(.13-.18). Rostrum reaching hind coxae; segments, III .20(.18-.20); IV .17(.14-.17); V .06(.06-.07). Length of hind tibia, 1.43 (1.33-1.49). Hind tarsal segments, I .10(.08-.10); II .25(.22-.25). Setae on hind tibiae, .07(.07-.08), equal to or slightly less than diameter of segment. Cornicle base .36(.36-.51) in diameter.

[1]Contribution No. 80, Division of Forest Biology, Science Service Department of Agriculture, Ottawa, Canada.
[2]Agricultural Research Officer.




*Cinara obscura* n.sp. a, b, c, d, e, alate viviparous female; f, g, h, apterous viviparous female.

HOST: *Picea glauca* (Moench) Voss. The aphids were found in colonies on the bark of the lower stems of small white spruce growing close together in seed-beds.

Holotype, alate viviparous female; morphotype, apterous viviparous female, mounted on the same slide: white spruce, June 27, 1950, Indian Head, Sask., deposited in the Canadian National Collection, Ottawa.

THE RUNGE PRESS LIMITED, OTTAWA
Mailed: Friday, December 4th, 1953